DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. VII. No. 82. OCTOBER, 1926 (Annual Subscription 12s.6d. Post Free). PRICE 1s. NET

DINOSAUR EGGS DISCOVERED IN THE GOBI DESERT.

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Editorial Notes.

What is believed to be the most important Mycenaean treasure brought to light in Greece since the celebrated gold cups of Vaphio were found in 1899, has been discovered at Dendra. While excavating under the leadership of Professor Persson during the summer, Swedish archaeologists unearthed an exquisite gold cup, which was found among other rich ornaments and vessels in a beehive tomb. An article by Mr. A. J. B. Wace describing the finds appeared in *The Times* of 10th September, based on a preliminary report received from the expedition. In this it is stated that the circular chamber in the tomb at Dendra was of rather small dimensions when compared with those discovered at Mycenae, and it contained four grave pits. On excavation, two of these appeared to have been disturbed in ancient times, probably still in the Bronze Age, to the later part of which the tomb belongs. Mr. Wace recalls that it was the custom of the Mycenaeans, when they came to make fresh interments in a family sepulchre, to push aside the previous occupants to make room for the new tenants, a process which lent itself to the removal of any valuable object that took their fancy.

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The other two grave pits, which were intact, were found to contain three richly-ornamented skeletons and these, from their size and apparent sex, were named the "king," the "queen," and the "princess." They all lay on beds of clay like the royal skeletons found by Schliemann in the wonderful shaft graves of Mycenae, and, like those princes, this king too was covered almost from head to foot with gold, silver, and other riches. On his breast lay a magnificent golden cup eighteen centimetres in diameter, cunningly chased with what we might almost call a submarine seascape. Just below the lip argonauts are seen sailing on the surface of the sea; between them rise the tails of dolphins, which are diving into the depths, where swim four large octopuses with all their tentacles outspread above a floor of coral-like rocks. From the artistic and technical point of view this cup is a masterpiece, and its delicate craftsmanship challenges the Vaphio cups, which have hitherto held first place among the wonders of Knossos and Mycenae.

The article concludes it is a noteworthy coincidence that these important new discoveries, which "take their place at once in the first rank among the wonders of the pre-Homeric Bronze Age of Greece," should have been made this summer, for August marked fifty years since the epoch-making excavations were begun at Mycenae by Schliemann, whose jubilee Mr. Wace discussed at the time in *Discovery*.

* * * * *

An interesting experiment in the creation of a definite bond between employers and workers engaged in a single business undertaking was announced last month by the Manchester Guardian and Evening News Ltd., the company owning the journals named. A society has been formed consisting of the adult permanent full-time employees engaged in the production and distribution of the company's newspapers. Without forfeiting their membership of ordinary trade unions, the members of the society will form a corporate "house" trade union, with a definite responsibility to promote the efficiency of the company's business, and a pledge to have all disputes settled by arbitration instead of by strikes. In the matter of wages, tenure of office, settlement of claims, pensions, etc., the members of the society have definite guarantees. The company, in return, have the valuable assurance of the workers' united interest in the prosperity of the concern and their pledge to maintain the uninterrupted service of the company's newspapers. Both the company and the society, while belonging to their

respective federations and trade unions, pledge themselves not to enter into any obligations in conflict with their liabilities the one to the other.

* * * * *

How far this scheme is likely to furnish a model for other businesses and to recover the true collective spirit in industry, it is not possible yet to say. But in this particular instance it would be a surprise if it did not work well, for under the inspiration of the editor, Mr. C. P. Scott, the *Guardian* office has long been recognized in the newspaper industry as one of its most notable clubs or brotherhoods of workers: in the words of the address which all the employees without exception joined in presenting to him on his seventieth birthday, "a fellowship of work" based on loyal co-operation and high ideals of service. The scheme is an interesting concrete example of employers and workers recognizing the common ends for which they labour together, and replacing sectional divisions and antipathies by a large constructive co-operation. It recognizes, too, a joint responsibility for the individual businesses in which both parties are concerned. The influence of such an example is bound to be good, in emphasizing the constructive and progressive side of trade unionism and discouraging the negative and divisive influences of its more extreme forms.

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We have received for review some further sets of the excellent picture postcards now being issued by the Natural History Museum. Originally introduced in consequence of the success which had attended the issue of similar cards at the Bloomsbury branch of the British Museum, and to meet a demand on the part of visitors for pictorial mementos, the series is gradually growing into an illustrated epitome of the museum itself, and is proving of great educational value. It is satisfactory to learn that the cards are in use in educational institutions of all grades, from universities to elementary schools, in the British Isles, in America and on the Continent; and, as the knowledge of their existence and usefulness spreads, a demand for them will doubtless grow up even in the more distant British Dominions and foreign countries.

Each set is accompanied by an explanatory leaflet, which, in addition to a general discussion of the subject illustrated, points out the interesting features of each picture, so forming a useful basis for a nature lesson. Both leaflets and cards are prepared by or under the direct supervision of specialists in the subjects dealt with; and the museum authorities see that as much care is taken with the pictures, from the point of view of accuracy, as if they were destined to illustrate scientific monographs, while at the same time no effort is spared to render them as attractive as possible. It is, in fact, endeavoured to ensure that the Natural History Museum picture cards are worthy of the institution which issues them, and that they maintain its authority and reputation. The sets now include representations in colour of all British butterflies, and of the eggs of practically all British birds; the sets we have received illustrate the British flowering plants, and a new and attractive feature is a series on precious stones.

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In view of the mass of literature unsympathetic towards the United States which is now finding its way into print—a phenomenon probably attributable to the international debt situation—it is encouraging to those who understand the American point of view to learn that the impressions of no less a critic than Mr. St. Loe Strachey are definitely favourable. In his "American Soundings" (Hodder & Stoughton, 12*s.* 6*d.*) we are glad to read that he is impressed with the American zeal for knowledge, and with the multitude and popularity of their universities. If this education is not yet always reflected in their culture, results are certain to follow from the equipment that is there; and Mr. Strachey found some of the universities he visited impregnated with the Oxford spirit.

* * * * *

Perhaps contrary to expectation, every visitor to America is impressed by the liberality with which business men there support educational institutions. An example that has just come to our notice is the endowment of a chair of literature in memory of Woodrow Wilson at Princeton University, of which he was president before he entered political life. The professorship is endowed by the gift of £30,000 from Mr. Edward Bok, an immigrant of Dutch origin who became a close friend and admirer of the late President. The first incumbent of the chair, "to commemorate Woodrow Wilson's mastery of spoken and written English," is Professor George McLean Harper, who is recognized as America's foremost authority on Wordsworth. A book review by Professor Harper appears on another page.

The foregoing paragraphs are prefatory to an announcement that the first of a series of articles on American universities will be published in *Discovery* next month. These will also deal incidentally with several aspects of American life, and in view of the visiting scholarships for British students founded of recent years they should prove of particular interest to prospective visitors.

The University of Hong-Kong.

By Sir Arthur Shipley, G.B.E., F.R.S.

As one of the outposts of the Empire Hong-Kong is now attracting particular interest owing to the disturbances in China. The Governor of the colony recently stated that only through the spirit of good will animating the students of its university can Hong-Kong, and indeed China, find the issue from its present troubles.

THE troubled state of affairs in China has been, to a great extent, fostered and promoted by the student body, most of whom have been educated in China. The sudden breaking-down of the old classical education and the substitution of modern western teaching has proved too much for them, and they have broken loose in a manner which, to put it at the best, has done no good to their country. It is satisfactory to find that the students of the Hong-Kong University have proved in every way loyal to the treaty engagements that the Chinese have made with other countries, and that up to the present* they have taken no part in the disturbances which have done so much to bring ruin to what was once a great country.

THE MAIN BUILDING OF HONG-KONG UNIVERSITY.
British firms in the East contributed liberally to its cost.

Seen from the sea, especially at sunset, Hong-Kong, like so many islands, seems singularly beautiful, but in the old days on landing, as is so often the case, one was apt to suffer a slight disillusionment. It is a mountainous island and its hills and ridges are composed of granite, syenite and serpentine, which afford a poor soil, and the numerous hills and winding valleys were rather bleak and rather dreary, with few trees or shrubs. The streams, which are many, could be traced by the straggling trees and the brushwood which edged their borders. But now, owing to the activity of the residents, the island has many beautiful gardens and is rapidly becoming well wooded, due to the planting of trees and shrubs by the British.

* September 21st.

The highest elevation is nearly 2,000 feet, and this height is reached by the Peak to the south-west of Victoria, the capital of the island, and the chief town. The island consists of a series of mountain ridges running N.E.-S.W., and the topography and outline are very complicated owing to the intensive denudation by the heavy rainfall and the drowning of valleys by submergence. Numerous granite spurs thrust themselves into the ocean and afford shelter for shipping. Two of these are specially marked on the southern coast, where they effectively shelter a couple of capacious natural harbours with good anchorage. The shore is usually flat and capable of being cultivated, but in some places it towers above the water in high cliffs.

The whole island is separated from the mainland by a distance of a quarter of a mile at its nearest point, but opposite Victoria you must traverse a mile of sea before reaching Kowloon Point on the Chinese coast. There is good holding ground with a depth of five to nine fathoms in the Hong-Kong Roads, facing the city. The island is situated some 75 miles from Canton, where everything has been done lately to destroy the prosperity of the colony.

The heat in Victoria is said to be something oppressive during the summer months, and many of the wealthy inhabitants have villas on the Peak which, being exposed to the south-west monsoon, escapes the great high temperature of the capital. During December and January the temperature frequently drops to 50 deg. in the city.

THE MAIN BUILDING VIEWED FROM THE SOUTH-EAST, showing the harbour and the mainland in the background.

Water is abundant, in fact the original name of Hong-Kong—Hiang Kiang—means the place of "Sweet Lagoons," and in level patches near the water-edge rice, yams, and sweet potatoes are cultivated, but not in sufficient quantities to supply the inhabitants. The chief industry is quarrying stone, the granite being used for building, but some of it is exported. Other industries are rope-making, sugar-refining, the manufacture of cement, and the building of ships. In normal times the port is an extremely busy one; vessels of all nations and of all kinds are constantly entering or leaving the harbour.

The centre of the town consists of three strips parallel with the sea. The "Praya," part of which has been reclaimed from the sea, forms an esplanade largely given over to the shipping industry. The view from the Praya is singularly beautiful, and tourists are enthusiastic as to the picturesqueness of the background. Behind the Praya comes the main business street, at each end of which there are Chinese quarters, where the populace is densely packed. Behind the business street the houses begin to climb the sloping sides of the Peak to a height of 1,000 to 1,500 feet, and here also we find Government House and other public buildings, surrounded by beautifully laid-out gardens, adorned with all the plants of semi-tropical vegetation; and here also we find the university. At Shakho, near the little fishing village of Stanley, a country club has recently been opened up, and a little farther off, in Repulse Bay, there is a very efficient hotel with excellent bathing.

The University of Hong-Kong was incorporated in 1911, and opened the following year as a resident university for students of both sexes. Its object as set out by ordinance is "the promotion of art, science, and learning, the provision of higher education, the conferring of degrees, the development and formation of the character of students of all races, nationalities, and creeds, and the maintenance of good understanding with the neighbouring country of China." This last sentence is perhaps the most important thing for which the University stands.

There are three faculties—medicine, with a five-years' course; engineering, with a four-years' course; and arts, which also extends over four years. This latter course it was hoped would train men for the higher grades of the Chinese Civil Service but, owing to the unsettled conditions which have for so long prevailed in the Republic, little success can be claimed on these lines. The standard of the degree is high, as high as that of the universities of Great Britain,

THE SCHOOL OF PATHOLOGY AND TROPICAL MEDICINE.

and in the examinations external examiners are most wisely associated with the teachers. The general course is modified, both in the curriculum and in the treatment of the subjects, to adapt it to the national intellectual outlook of the Chinese student, and the whole institution is intended as a contribution to the intellectual progress of China from a British colony whose prosperity depends on international trade, and can only prosper in an atmosphere of mutual understanding.

The cosmopolitan spirit of the place is reflected in the various nationalities of the undergraduate body. The majority are naturally Chinese, and of these a large number come from Hong-Kong and the Straits Settlements; some come from the north, centre and west of China, and were things more settled undoubtedly these numbers would increase; other Chinese come from Australasia and the Dutch East Indies, and Ceylon, and there is a sprinkling of students of pure British descent, and also of Portuguese, Japanese, and other Eastern peoples. There are three university hostels, which are supplemented by two similar institutions maintained by differing missionary bodies. At present the five hostels in existence are full. Each student has a room to himself, and each building is in charge of a warden, with whom are associated an elected committee of students. The hostels are two-storied with deep verandas on all sides. There are also houses for the Principal of the university and for the various Professors.

THE ANATOMY AND PHYSIOLOGY SCHOOL, HONG-KONG UNIVERSITY.
The architecture shows an English tradition.

The singularly handsome central building was erected at the expense of Sir Hormusjee Mody, a Parsee gentleman resident in Hong-Kong. English firms in the East, especially the firm of Butterfield & Swire*, also contributed liberally, and many of the wealthy Chinese merchants have most generously helped. The Ho family built the School of Pathology and Tropical Medicine, and Sir Robert Ho Tung largely financed the engineering workshop. Many Chinese provinces and towns also contributed, and recently the Rockefeller Foundation has provided an endowment for full-time professors of surgery, of medicine, and of gynecology and obstetrics. The main building shows an English tradition, but the slender Ionic colonnade is rather spoilt by being cut in two by a veranda exhibiting the influence of the American colonial style. The turrets show a somewhat repressed baroque style, such as Christopher Wren used in his later buildings. The Anatomy and Physiology School has, again, an English appearance, and their style is that which was common after the Tudor period. The rustication of the brickwork on the lower part, which is carried up the corners as quoins, serves to give scale to the wall divisions. The pediment over the central door is again reminiscent of Wren's best work. The whole building is set in grounds of singular beauty, backed by the Peak and overlooking the town on the roadset. The colony gave the site, and it is so situated that it can be added to as the university grows.

The staff is very efficient, but far too small, and they consequently have to do too much teaching, which leaves but little time for study and research.

Sir Frederick Lugard who, with the aid of others, was the main instrument in the foundation of this outpost university of the Empire, intended and hoped that it would form a centre of friendly contact between the great Chinese Republic and the scattered British Empire. In a speech on the opening day, he said:—

My conception, then, of this scheme is that it shall stand as a proof that the citizens of a British colony are not solely engrossed in the pursuit of wealth, but that they realize the obligations

* It is interesting to note that the recent incidents involving the British fleet followed the seizure by Chinese rebels of two vessels belonging to Messrs. Butterfield & Swire.

which lie upon them to extend to subject races and to neighbouring and friendly peoples the benefits which the energy of their forefathers have conferred upon themselves. That Hong-Kong shall lead the way among Crown colonies is proving anew that the British Empire is not merely a vast trading corporation, but has still the sacred fire of imperial responsibility and is content to cast its bread upon the waters, without looking to immediate gain, assured that it will return after many days.

By these means and by the selection of the very best men for the staff, together with the collateral assistance of the Chinese gentry and of various associations and missions, we hope to ensure that the best possible tone and feeling shall exist among the undergraduates and that the university shall never be open to the reproach that it provides a secular and materialistic education to the neglect of what is infinitely more important—character, integrity, and the standard of life.

Just at present perhaps these hopes are not being realized, but as they have been in India so in China, in time, things will become better, and the younger amongst us may live to see this hope and inspiration of Sir Frederick Lugard realized in full. In the picturesque language of his Excellency Wei Han :—

A university in Hong-Kong is welcomed by the Chinese. It will be a nearby tree of knowledge from which the leaves of learning may easily be plucked and passed from hand to hand among the people of the southern provinces of China ; it will afford the grateful shade of erudition to the young men of China who may not be able to go farther afield for it ; and it will by its benefits swiftly convince the still unconvinced among the Chinese that education is a mighty factor in promoting national greatness, and the only fulcrum that can be used with any chance of success in levering the people as a whole to the plane of enlightened and progressive life that should be lived. For these reasons a university in Hong-Kong is appreciated and supported by the thinking section of the Chinese, and their Excellencies the Viceroys join with that section of their countrymen in wishing lasting good and future greatness to the university, as well as sound and enduring good from it to Hong-Kong and China.

The university has already justified and more than justified its existence, and will in course of time take an even more conspicuous part in promoting good relations between two great and self-respecting nations.

Last November the University Union gave a reception to Sir Cecil Clementi (then Mr. Clementi), the recently chosen Governor of Hong-Kong. The Governor recalled the active part he had taken in the foundation of the university, and expressed his gratitude for the intimation which he had received whilst in British Guiana that the university wished to confer upon him the title of LL.D. He paid a tribute to the loyal manner in which the students had supported their university during the recent troubles. He reminded his audience of the famous verse in a Chinese classic :—

Within the four seas all are brothers,

and he strongly advocated the close study of Chinese classics as a wholesome antidote to much poisonous doctrine that had been spreading through China by men who have at heart neither the good of China nor of mankind at large. Sir Matthew Nathan in an eloquent address recalled the great part that Sir Frederick Lugard played in the initiation of the university. The Vice-Chancellor, Mr. W. W. Hornell, stated that the University of Hong-Kong aims at training gentlemen in the truest sense of that much-abused term. "Those of us who are in authority here rejoice in the courtesy and good will which, in spite of the storms which rage round about us, still animate the students of this university. We believe that it is in this spirit of courtesy and good will, and in this spirit alone, that Hong-Kong, nay China, will find the issue from its present afflictions."

The Bible in Esperanto.

An interesting event in the history of language is the publication of the whole of the Bible in "Esperanto" by the British and Foreign Bible Society and the Bible Society of Scotland. The Old Testament translation was made by Dr. Zamenhof direct from the Hebrew, while the New Testament is a revised edition of the Esperanto version published in 1912. The present translation has involved many years of painstaking work by experts, and is believed to be one of the best existing in any language.

The Value of Books.

In a competition organized by Messrs. W. & G. Foyle Ltd., booksellers, of 121-125 Charing Cross Road, London, to discover which is the most widely-known reference in English literature to the esteem in which good books should be held, we are informed that "As good almost kill a man as kill a good book," extracted from Milton's *Areopagitica*, took premier place. Although the competition has now closed, our correspondents would be interested to know if there are other better-known references to the value of good books.

In the matter of material worth, it is of interest to note that copies of No. 1 of the *British Gazette*, the official newspaper issued by the Government during the general strike, now very scarce, are at the present time changing hands at a guinea each. Anyone who possesses a copy should take particular care of it, as it is anticipated it will be of still higher value in the near future.

The New Gibraltar Skull.

By E. N. Fallaize.

Honorary Secretary of the Royal Anthropological Institute.

As the earliest recorded discovery of a skull of the Neanderthal race of man was made at Gibraltar in 1848, great interest attaches to a second specimen which was unearthed there a few months ago by Miss Garrod, and described to the British Association meeting at Oxford.

DURING the present century remarkable additions have been made to our knowledge of prehistoric man of the Early Stone Age. Not only is this true of the material and artistic sides of his life as exemplified in weapons and implements, in the carvings and engravings on ivory and bone or the rock paintings of the French and Spanish caves; we have learnt much of his physical characters, and can now form with reasonable probability some idea of his appearance and broadly of the evolutionary stages by which he attained the dignity of *homo sapiens*. But there are many gaps still to be filled. The researches of Sir Arthur Keith have carried back modern man to a stage in the world's history far earlier than was once thought possible. Yet the ancestral form of modern man in the line of filiation is still to seek, and it is perhaps not without significance, while it adds something to the difficulties of interpretation, that the most striking discoveries of the last few years relate to a type which is sharply distinguished by many peculiarities from man as we know him to-day.

An Earlier Discovery.

The brief announcement which appeared in *The Times* in June last that a prehistoric human skull had been found by Miss D. A. E. Garrod at Gibraltar on 11th June, was of intense interest to anthropologists; and the further statement that it was associated with Mousterian implements added to the importance which was attached to the find. For this was not the first prehistoric skull to be found at Gibraltar. In 1848 Lieut. Flint, R.A., discovered a skull which was brought to England in 1862 by Mr. George Busk. Its peculiarities were recognized, and a specific name was proposed for it; but it was only comparatively recently that its full significance as a variant of the Neanderthal type was appreciated. Although the skull found in 1857 in the valley of the Neander in Germany has since come to be regarded as the type, and has given its name to Neanderthal man, the Gibraltar skull is now recognized as the earliest recorded discovery of a member of this race of man.

Unfortunately, no data are available of the conditions of the discovery of the Gibraltar skull, nor is it known whether any stone implements or remains of animals, extinct or other, were found in association with it which would have given a clue to its probable date, Apart from its intrinsic evidence of a high antiquity. its dating rests upon its general resemblance to the type skull. But it presents marked differences from the type, and allowances have to be made for variation due to sex, for it is now generally admitted that in all probability it is a female. There is, however, evidence which places it beyond question that prehistoric man had made the Rock his home. Long after the discovery of the skull, Capt. Broom, in the years 1863-68 explored a number of the Gibraltar caves and made a collection of a number of bones of animals of species found in Quaternary deposits, including *Rhinoceros Merckii*, worked flints, and quartz pebbles. This collection, unfortunately, has now disappeared. Excavations by Dr. W. L. H. Duckworth in 1910 on the site of Forbes Quarry, where the skull was found, produced no human remains, it is true, but Mousterian implements were found. When, therefore, Miss Garrod's discovery was announced, it was at once apparent that should the skull prove, as was expected, of Neanderthal type, its association with Mousterian implements was a remarkable corroboration of and addition to the significance of previous discoveries. It promised to clinch the argument that the earlier skull was of Mousterian Age, a period to which it had been assigned on the ground that other skulls of Neanderthal type had come from deposits belonging to this phase of the Palaeolithic period.

The New Specimen.

The newly-found skull was brought to the Department of Human Anatomy of the Oxford University Museum early in July last. It had been announced that it would be exhibited at the meeting of the British Association to be held in Oxford in the beginning of August; but nearly the whole of the month which intervened was occupied in removing part of the skull from the matrix in which it had been brought to this country. The reason for this was made apparent when an account of the discovery was given by Miss Garrod to the Anthropological Section

of the Association, and the circumstances in which it was found were described.

The site on which Miss Garrod carried out her excavations was a cleft in the rock on the north side of Gibraltar. It was about 150 yards east of Forbes Quarry, and opposite an abandoned signal station known as the Devil's Tower. This cleft had been visited by the Abbé Breuil on several occasions in 1914, 1917, and 1919, and had yielded a few stone implements of Mousterian type, and an abundant fauna of species known to occur in Pleistocene deposits, including the hyaena. It was in fact at the Abbé's suggestion that Miss Garrod started excavating on this spot.

Without entering minutely into the results of the excavation which Miss Garrod described at Oxford, and of which a fuller account will be given before the Royal Society in due course, it is enough to say that it was found that the cave contained, under the superficial sand, no less than seven distinct superimposed strata of deposits lying on a raised bench. Of these five contained stone implements. The deposits emerged from the cave and spread out in front fanwise in a series of steps. They contained a large number of bones, broken and burnt by man, but it was also clear that the cave had been used as the lair of beasts of prey. As it faced north, it seems probable that it had been used as a human habitation only in summer and had been abandoned in winter. The animal bones included remains of deer, goat, boar, rabbit and, rarely, horse and ox. At the foot of the deposits and resting upon the raised bench was a carpal bone of an elephant. A large number of edible shells and fragments of the carapace of tortoise were also present.

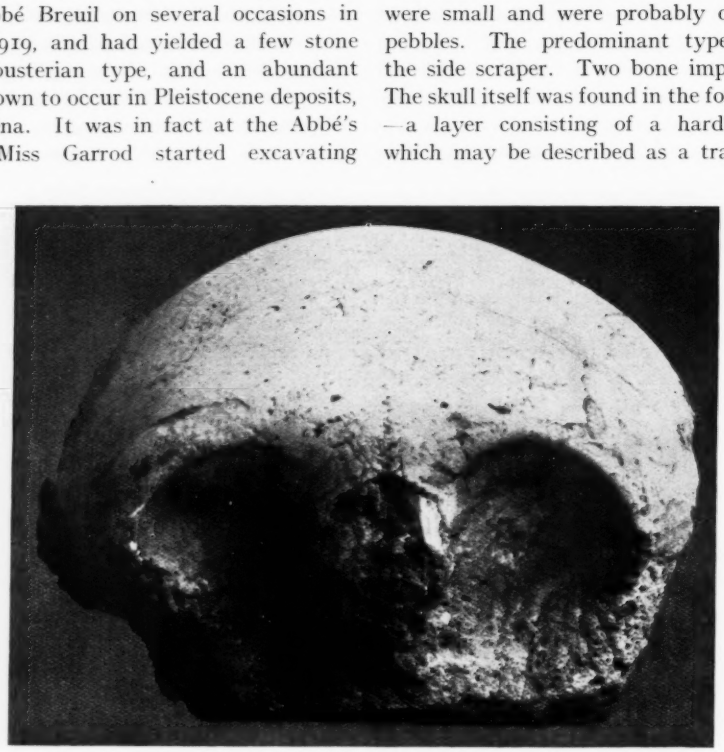


Fig. 1.
FRONTAL BONE OF THE NEW GIBRALTAR SKULL, FOUND AT THE DEVIL'S TOWER.
Note the flattened cranial vault, and the incipient stage of growth of the eyebrow-ridges.

The implements found were of Mousterian type, and those from the second stratum were especially well fashioned. They can with some confidence be referred to the Upper Mousterian, a point of some importance in any attempt to establish a relative chronology of the various strata. The implements were for the most part of quartzite—pebbles of which could be obtained from the Spanish rivers, the reason for their employment being that no flint is to be found at Gibraltar. Such flint flakes as were found were small and were probably obtained from beach pebbles. The predominant type of implement was the side scraper. Two bone implements were found. The skull itself was found in the fourth layer of deposits—a layer consisting of a hard tufaceous material which may be described as a travertine. This layer has a maximum thickness of 1m. 50. Large blocks of limestone were embedded in it, and this, combined with the hardness of the material, made it necessary to employ dynamite to break up the stratum. In the course of removing one of the limestone blocks, the explosion caused a number of fissures, in one of which, about 15cm. from the surface of the stratum, a thin edge of bone was revealed. This proved to be a human frontal bone in an entire state. It rested upside down in a kind of mould, and was removed without difficulty. Further search brought to light at a distance of about 50 cm. away, a left parietal bone, but this was so firmly embedded in the travertine that a mass of the material had to be detached whole with the skull, and was brought to England in this state for reduction in the safer conditions of the laboratory. Further search failed to bring to light any more fragments of the skull. A number of implements of flint and quartzite were found in this stratum, and although they are less well made than those of the upper levels, they are definitely of Mousterian type. The conditions in which they were found precludes any chance of disturbance by which they

might have been fortuitously brought into association with the skull. All the objects found in this stratum must have been deposited more or less contemporaneously. It is therefore possible to pronounce without hesitation that the skull is of Mousterian age.

It will be seen (Figs. 1 and 2) that the whole of the upper part of the front and the greater part of the left side of the skull have been preserved. When the freeing of the left parietal from the matrix in which it had been brought to England had been completed, it was clear that the two bones belonged to the same skull. This condition makes reconstruction by duplication of the parietal to provide a right side for the skull relatively a simple matter.

The delicate and tedious task of removing the parietal bone from its matrix by a slow process of careful chipping and the examination of the skull when thus made ready were entrusted to Mr. L. H. Dudley Buxton of the Human Anatomy Department of the Oxford University Museum. As already stated, the process of clearing the skull from deposit was so prolonged that little time had been available for study before the meeting of the British Association, and the results which Mr. Buxton was able to put before his audience were of an entirely tentative character.

FIG. 2.
SIDE VIEW OF THE FRONTAL BONE AND THE LEFT PARIETAL BONE, PLACED IN POSITION TO SHOW THAT BOTH ARE PARTS OF THE SAME SKULL.

As is generally well known, one of the more marked characteristics of the Neanderthal type of skull is the very prominent protuberance of the eyebrow ridges. A reference to the illustration of the frontal bone will show that in this specimen this character, though not entirely absent, is only in an incipient stage. Yet the general appearance of the frontal bone is infantile, and other features of the fragments point to the conclusion that the skull belonged to an individual of immature age. So far as at present studied, nothing serves to indicate the sex of the individual. Mr. Buxton has made a careful and detailed comparison with the characters of skulls of other individuals of the Neanderthal type of immature age. Five finds of immature Neanderthal skulls are known, but not all are yet available for study by means of casts. They are the fragments, much broken, of a skull of a child of about five years of age discovered at La Ferrassie which, however, are not available for comparison; the skull caps of two children found at Krapina in Jugoslavia, also not available for comparison; the skeleton of a youth of about sixteen found at Le Moustier in the Vézère Valley in France; and the fragments of the skull of a child of about eight years of age unearthed at La Quina, also in the south of France. The contrast of these skulls with those of the modern European child is striking and, in like manner, the same contrast is apparent in a comparison of the Gibraltar specimen with the modern child, particularly in the form of the frontal bone and the extreme flattening of the skull, both absolute and relative. This flattening is a marked feature of all Neanderthal skulls. It is not confined to the forehead, but includes the whole of the cranial vault.

In regard to measurements, the absence of the occipital protuberance at the back of the skull, and the fact that the right side of the skull upon which measurement was taken was a duplication of the left parietal which had been hastily made for purposes of exhibition, deprives the calculations which were tentatively put forward by Mr. Buxton of any final character. On these data he calculated a possible percentage of breadth to length of 80. A cephalic index of this figure gives a broad head, and Neanderthal man does not fall within this brachycephalic group, but is long-headed—dolichocephalic. It would seem, therefore, only fair to regard the measurement of the skull as in suspense, and subject to revision. Further and more careful calculation may, however, show its approximate accuracy, in which case the marked breadth must be regarded as an infantile character

which, as in modern children, would have been modified at a later stage of growth.

It will readily be agreed that the tentative conclusions put forward by Mr. Buxton, of which he himself emphasizes the provisional character, are sufficient to confirm the first impression of the importance of Miss Garrod's discovery. If for no other reason, it would be of moment as an addition to our knowledge of the stages and process of growth to maturity in Neanderthal man; and researches in other fields of anthropology are demonstrating the importance of the study of growth in the immature children for the interpretation of the physical characters of man and the anthropoids.

It may be asked, How far,if at all, has this discovery made any significant addition to our knowledge of prehistoric man—How far has it helped to elucidate the problems of man's origin, descent, and early distribution? No final answer can be given until after a closer examination and discussion of details of a highly technical character. Of the general question of Neanderthal man, it is too late to speak here, but it must be obvious that every fresh discovery adding to our knowledge of this remarkable race, which presents so many problems for solution, must be of the utmost value. Of man of the earlier Chellean and Acheulean periods of the Palaeolithic Age we know little, though the Piltdown skull is a document of priceless value, and in the Mauer Jaw found at Heidelberg nearly twenty years ago we seem to have a progenitor of Neanderthal man. It may be regarded now as firmly established—and this recent discovery confirms this view—that in the following Mousterian period the prevailing type was that of Neanderthal man, flourishing perhaps as long ago as 40,000 years, and in the final phases of the palaeolithic period, the Aurignacian, Solutrean, and Magdalenean, he vanishes. His distribution in space was wide, France, Belgium, Jersey, Central and Eastern Europe, Spain, and Malta —possibly an indication of the road over the land bridge by which he may have crossed from Africa—and Palestine, while in Rhodesian man we have a type closely akin. It is at least curious that while many implements of Mousterian type have been found in England, no skeletal remains of Neanderthal man have come to light. If this brutalized Simian type, with its heavy overhanging eyebrow ridges and projecting muzzle, can no longer in generally accepted theory claim pride of place as a direct ancestor of modern man, the mystery of its origin and its sudden disappearance has a no less strong hold on the imagination.

In conclusion I would wish to express my thanks to the Department of Human Anatomy of the Oxford University Museum, and to Miss Garrod for the photographs here reproduced.

Correspondence.

THE STRUCTURE OF THE ATOM.

To the Editor of DISCOVERY.

SIR,

Your reviewer in his notice of my book, "Reflections on the Structure of the Atom," accuses me of making the sweeping assertion that gamma rays consist of atoms of hydrogen and advises me to make a few experiments myself. I shall certainly not follow his advice, as I should put no faith in any experiments in this subject made by less competent observers than Sir Ernest Rutherford and Dr. Chadwick, with the resources of the Cavendish Laboratory at their command. But one is allowed to draw deductions from their experiments, especially as the whole matter is in such a confused state that, as Sir William Bragg remarked, we believe in the quantum theory on Mondays, Wednesdays and Fridays, and in the wave-theory of light on Tuesdays, Thursdays and Saturdays. We know that the atom yields, when disintegrating, alpha rays—which become atoms of helium—beta rays (electrons) and gamma rays—which, we are told, are simply X-rays of a very high frequency. As the atom is undoubtedly built up of hydrogen atoms we can understand its losing hydrogen atoms when it breaks down into an element of lower atomic weight either in the form of alpha rays—which some of the atoms may group themselves to form—or as hydrogen atoms simply. As nothing else leaves the atom save electrons, it would seem that the departing gamma rays are hydrogen atoms. This receives confirmation from the fact that when Sir Ernest Rutherford bombards a very light element he gets a hydrogen atom. Thus it would appear that when the atom escapes from a light element it has so low a frequency that it soon loses its ray form and shows itself as a hydrogen atom. When, however, it is shot from a heavier element, it has a higher frequency, and so we know it as an X-ray, save when it is shot from the heaviest elements of all, when it has such a high frequency that it is known as a gamma ray.

I venture, therefore, to think that I am right in making the assumption that the gamma ray is a hydrogen atom. I did not state it as a fact, but gave the evidence, as here, in favour of its being so. Then, having made this assumption I had to treat it as such in showing how an atom of the structure described would be affected by the loss of such a gamma ray. And this atom gave further evidence in support of this supposition, but it would take too much space to describe it here since it relates to the way the atom is built up—the which apparently shows that a hydrogen atom escapes when an element that is not a twin-element breaks up. In the latter case an alpha ray (helium atom) goes instead. Seeing that our atom consists of hydrogen atoms we are surely right in assuming that when it changes

into an element of lower atomic weight and thereby loses a ray, that that ray is either a hydrogen atom or a combination of the same as in the alpha ray.

Yours faithfully,

Claygate, Surrey. FLORENCE LANGWORTHY.
16th August, 1926.

Commenting on this letter, the reviewer, Dr. A. S. Russell, writes :—" I cannot see how the confused state of the quantum and wave theories mentioned by Miss Langworthy has any bearing upon her identification of the gamma ray with the hydrogen atom. If a gamma ray is a hydrogen atom then, whenever gamma rays are expelled hydrogen should be produced ; but hydrogen, although often looked for, has never been found as a product of the disintegration of atoms expelling gamma rays. Again, if a gamma ray is a hydrogen atom then the atom, after expelling a gamma ray, should weigh one unit less than it did before, the unit being, of course, the weight of the hydrogen expelled. Now radium in its disintegration is known to expel five alpha rays (each of which weighs four units) and at least four gamma rays. On the orthodox view the weight of radium should be diminished by twenty units, on Miss Langworthy's view by twenty-four, on complete disintegration. The experimental answer is twenty, and the evidence is therefore once more against Miss Langworthy.

" Further, Miss Langworthy says that an atom is ' undoubtedly built up of hydrogen atoms.' I have never heard of anyone but her who believes this. There is experimental evidence that either the nuclei of *some* light atoms or alpha rays contain hydrogen nuclei, but that is a different thing. Again, there is no experimental evidence at present for the commonly held view, which she endorses, that hydrogen nuclei inside the atom group themselves to form the alpha ray ; it is a possibility but, at present, nothing more. Miss Langworthy's case, as it appears to me, is : atoms are composed of hydrogen and electrons ; there are only three kinds of rays expelled, these are therefore likely to be composed of hydrogen and electrons ; the alpha ray is a composition of hydrogen, the beta ray is an electron, therefore the gamma ray not being an electron is a hydrogen atom. This, I agree, although illogical, is ingenious, and ought to be tested experimentally either by herself or by somebody interested in this view ; the more so because such experimental evidence as we have is definitely against it."

BRITISH STEREOSCOPIC CAMERAS.

To the Editor of DISCOVERY.

SIR,

In the recent review of my book on " Stereoscopic Photography " one or two statements are made which may give your readers a wrong impression. It is stated that stereo cameras are no longer made in England, and that the hobby " is practically limited to the Continent." This is untrue, for such firms as Messrs. Thornton Pickard, Messrs. A. Adams & Co., the manufacturers of the " Soho " reflex camera, etc., make stereo cameras in this country. One of the principal reasons why more cameras are not made by British firms is undoubtedly the excellence and higher standard of development of the German and French stereo cameras which are flooding this country. That the hobby of stereoscopic photography is not limited to the Continent is evidenced by the large and constant increase in the membership of stereoscopic societies in this country, and to the increased importance given by the Royal Photographic Society to stereoscopic matters and exhibits. The review states that " the applications of stereoscopy are important in X-ray practice, in aerial reconnaissance, etc." Stereoscopy, however, is used to a considerable extent *not* for reconnaissance but for aerial survey purposes by the photographic mapping process ; incidentally, it is largely used for phototopography. It is also stated that the revival of this form of photography is not to be expected. Not only has there been a welcome increase in the sales of stereoscopic apparatus in this country of late, but also several commercial firms have taken up and are utilizing stereoscopic methods for advertising and other purposes.

Trusting that you will in fairness give this letter the same prominence as the review in question.

Yours faithfully,

Farnham, Surrey. A. W. JUDGE.

" THE COMPOSITION OF THE UPPER AIR."

To the Editor of DISCOVERY.

SIR,

In his article on " The Composition of the Upper Air," Mr. Britton states that Prof. Vegard obtained a spectrum very like that of the aurora, including the prominent green line, by bombarding solid nitrogen with cathode rays.

This is not strictly correct for, although Prof. Vegard obtained a spectrum similar to that of the aurora with solid nitrogen, this did not contain the bright green line (5577 Å), a band being present in its place. It was only when he condensed mixtures of nitrogen and neon, with decreasing percentages of nitrogen, that he found the position of the principal maximum (5550 Å) of this band began to shift when the percentage of nitrogen fell below 30, and that, as the percentage of nitrogen approached zero, this maximum took the form of a diffuse line whose brightness dominated the spectrum, and whose position coincided with that of the aurora line. In other words, it was only when the nitrogen was presumably present in the form of small, widely dispersed, particles embedded in the layer of solid neon (which was without specific influence) that a spectrum really like that of the aurora was obtained. The evidence pointed to the luminescence in both cases as originating from essentially the same physical systems, and Prof. Vegard was therefore lead to the explanation of the origin of the aurora which Mr. Britton quotes.

Prof. McLennan in Toronto has certainly claimed to have obtained this bright green line from mixtures of oxygen and helium, but the spectrum also contained a large number of other lines, many of which were helium lines, and as Mr. Britton says, no helium lines occur in the aurora spectrum. Besides, I do not believe that any of the other aurora lines are claimed to be present, whilst Prof. Vegard has obtained an almost complete aurora spectrum.

Yours faithfully,

41 Peak Hill, S.E.26. R. O. GIBSON.
8th September, 1926.

Mr. Britton writes : " As your correspondent points out, the neon was without specific influence, at least as far as the observed spectrum was concerned. It was presumably the bombardment of the admixed *nitrogen* which produced the spectrum resembling that of aurora. It may be mentioned that the Vegard hypothesis has been attacked on general grounds in this country notably in a paper by Atkinson."

*

American Discoveries in the Gobi Desert.

Special Photographs of the Expeditions.

As announced in last month's editorial notes, the American Museum of Natural History has courteously sent some photographs of their Mongolian expeditions for special publication in DISCOVERY. *The illustrations, reproduced on these pages, reached England on 20th September.*

IN the course of the lecture on the American expeditions to the Gobi desert, which he delivered to the recent British Association meeting at Oxford, Professor Henry Fairfield Osborn said that "the fascination and the perils of fossil-hunting among the Flaming cliffs of Djadokhta for the eggs and skeletons of dinosaurs were recorded by instantaneous photographs."

Following the lecture,* the editor at once made arrangements with Professor Osborn to enable *Discovery* to publish some representative photographs taken by the expeditions; and these have just reached this country from New York, whence they were sent to us by the American Museum of Natural History, of which Professor Osborn is director. In reproducing the accompanying plates our thanks are due to the museum authorities for the courtesy afforded us.

The Photographs.

The photographs show :—

(1) Expedition caravan of 125 camels seen at the base of the Flaming Cliffs, Djadokhta.

(2) Granger and his two Chinese assistants unearthing the skull and skeleton of a dinosaur.

(3) Near view of a dinosaur skull found at Shabarakh Usu.

(4) View of the remains of one of the oldest alluvial deposits of the Altai Range, looking north.

(5) Caravan entering the valley of Shabarakh Usu, where dinosaur fossils and prehistoric implements were discovered.

(6) Twelve dinosaur eggs.

(7) A selection of prehistoric stone and flint implements discovered in the valley of Shabarakh Usu.

(8) Examining the stratum from which the implements weathered out.

A new volume in the life-history of the earth has been revealed by the discoveries in Mongolia in 1922, 1923, and 1925, for these have confirmed the prediction made by Professor Osborn so long ago as 1900 that the unknown plateau region of Central Asia would prove to be the chief centre of the origin and distribution of the waves of migrating land reptiles and mammals which successively spread into every other continent.

As illustrative of the method by which the paleontologist interprets the story of animal life by means of fossils discovered in the various layers of the earth's crust, Professor Osborn reminded his Oxford audience that a stratum had been found in the Gobi Desert containing fossils of animals related to the dinosaur that had been unearthed in 1799 by William Smith, in the Oxford clay of equivalent age in Southern Britain.

Camel and Motor Transport.

In a description of the practical carrying out of the expeditions, it was stated that

By combining a very large caravan for the camel transport, which left Kalgan on 1st December, and reached the eastern base of the Altai Range on 1st May, with an automobile train of five to seven cars, the expedition had the great advantage of speed over the previous geological explorers who crossed the desert with camels only. The geologists and palaeontologists of the party, Granger, Berkey, and Morris, with two field assistants, also had the advantage of prolonged experience in the field formations of the western United States which, between the fiftieth and fortieth parallels of latitude, present conditions remarkably similar to those found in the Desert of Gobi.

The transport was conducted under the guidance of ten Mongols, ten Chinese, and an equal number of Americans trained in the western desert region. These rapid modern methods were rendered possible by the approval of the Mongol Government, but neither aeroplanes nor radio were allowed admission. Over the great level stretches now traversed by wild asses and gazelles, the camels advanced fifteen miles a day, the automobiles a hundred and fifty miles a day, or ten times as rapidly.

The photographs themselves are sufficiently suggestive of the romance attaching to these expeditions into Mongolia, a land "of painted deserts, dancing mirages, limitless plains and nameless suncapped peaks"—to quote a preliminary notice of a book* just written by their leader, Roy Chapman Andrews, in which some of the accompanying illustrations are also reproduced.

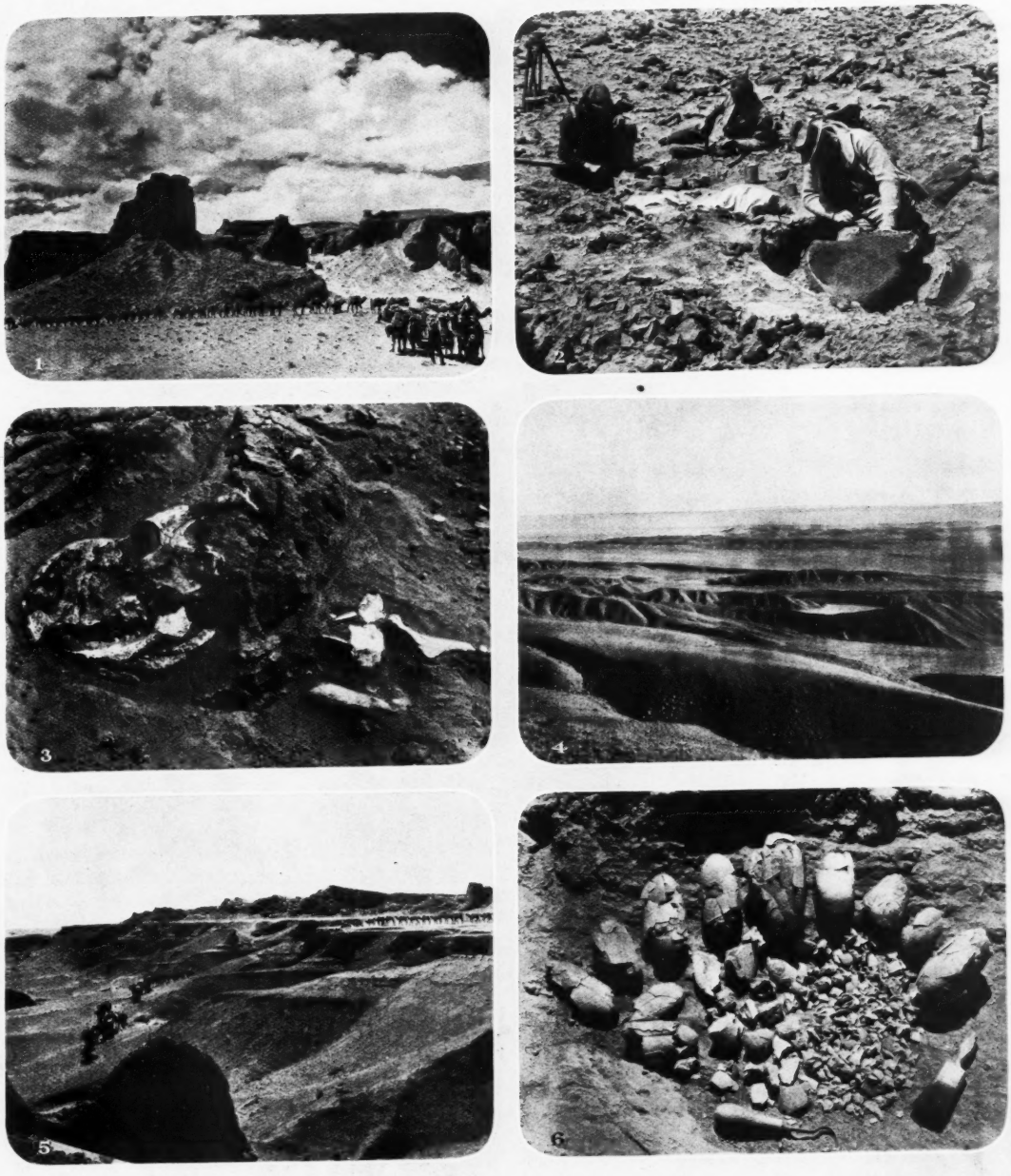
Chief Scientific Results.

In a paper to the Geological Society, Professor Osborn summarized the chief scientific results of the expedition as follows :—

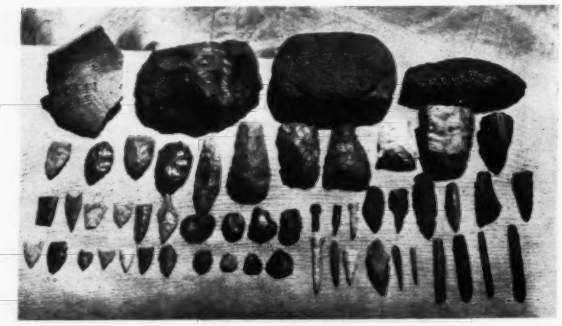
First, this Central Asiatic continent of Gobia, as it has been named by Grabau, was for several millions of years extremely

* Reported in full in *Nature*, 18th September.

* "On the Trail of Ancient Man." By Roy Chapman Andrews. (Putnam).



PHOTOGRAPHS TAKEN DURING THE AMERICAN EXPEDITIONS TO THE GOBI DESERT.



GOBI DESERT PHOTOGRAPHS (FIGS. 7 AND 8).

favourable to the evolution of reptiles, mammals, insects, and plants, and probably birds as well, of which fossils have also been found in the low-lying Cretaceous forelands of western Europe (such as the Wealden of England and Belgium), and in less degree of southern Asia. Secondly, this now terribly desert region of Gobia, traversed only by the gazelle and the wild ass, and thoroughly uninhabitable in the summer season, was abounding in life throughout Upper Jurassic, and throughout all Cretaceous and Tertiary time, sparsely forested, traversed by streams and rivers, with a limited seasonal rain-supply like the high-plateau region of Central Africa to-day. Thirdly, these dry and stimulating upland conditions of Tertiary time, as compared with the densely forested conditions of the Asiatic lowlands, have led to the recent prediction by the lecturer on returning from Iren Dabasu in 1923, that this region is the most likely one in which to search for the Tertiary ancestors of man, namely, those of Eolithic or Dawn-stone Age, though no traces of man have, as yet, been discovered by the expedition older than those of Lower Palaeolithic age. The discovery of human and pre-human remains in Tertiary time has thus become one of the chief remaining objects of the expedition.

Stone and Flint Implements.

During the season of 1925 stone and flint implements and other evidence of a great habitation site, probably of Azilian-Campignian time, was discovered on the eastern slopes of the Altai Range, not far from Shabarakh, and not far from Djadokhta, where the now famous dinosaur eggs were discovered, far north of the Ordos locality explored by Licent and Teilhard de Chardin. In fact, these artisans of the Upper Palaeolithic period collected the broken shells of the dinosaur eggs with which to manufacture necklace ornaments, these perforated fossil shells serving as well as the recent eggshells of the giant Struthiolithus, the great ostrich of the Stone Age of Mongolia.

No human fossils have so far been found; the industrial levels are not as yet precisely determinable, but the chief anthropological fact is established that the Stone Age tribes spread over the borders of the Gobi Desert region during the Ice Age, establishing their quarries near the large lakes bordering the Altai Mountains on the east and fed by glacial streams. The geologists of the party have discovered traces of this glacial age along the summits of the Altai Range.

The foregoing notes on the American expeditions' work may fittingly be concluded with a remark from Professor Osborn's lecture at Oxford. "Scientific truth," he said, "is far stranger than scientific fiction: Gobia takes the place of the mythical Atlantis and other imagined continents, as the source of most of the animal civilizations and probably also of most of the vegetal civilizations of the northern hemisphere."

REVIEW.

The Southern New Hebrides: An Ethnological Record. By C. B. HUMPHREYS. (Cambridge University Press. 12s. 6d.).

Mr. Humphreys belongs to a class of Americans which is becoming increasingly common, that is to say, he is a man who, having made a moderate fortune in his youth, is devoting his well-earned leisure to scientific research. Mr. Humphreys joined Christ's College, Cambridge, some years ago and, under the inspiration of Dr. Haddon, has devoted a considerable period to the exploration of the Southern New Hebrides, more especially the exploration of the natives that inhabit these islands. In his preface he modestly states that his ethnological record is guiltless of any literary popular claim but, although in the main the book is one of statistics and native terms of relationship, the customs of the inhabitants of the Southern Hebrides are set forth clearly and concisely, and the writer's style is by no means devoid of a literary grace. Cook seems to have been the earliest European to visit the islands, which he did on his second voyage and, apart from him and Erskine, what little we know of this part of the world is due to missionaries.

There is no doubt whatever that one of the most crying needs of the present day is anthropological investigation, because every week the older natives, who knew the ancient customs, are dying off and every week the surviving natives become more veneered with white civilization. To get at the truth in such matters it is of the utmost importance to establish a sympathetic understanding between the inquirer and the "elders." As a rule the man who was being cross-examined was accompanied by friends who readily interfered if they disagreed with his statements. Of course, one of the great troubles the investigator has is that much of the work must be done through interpreters and, as everybody knows, interpreters are apt to vary the statements they are supposed to transmit.

The work deals in the main with the five islands under the following headings:—Tanna, Anaiteum, Futuna, Aniwa, Eromanga. Four of these islands and their natives are of minor importance. But the book is rather of the nature of an encyclopaedia than a work which can be read straight through.

A. E. S.

Chemistry and the Sense of Smell.

By T. W. Jones, B.Sc.

As discussed in a recent article on the sense of smell, various explanations of its nature have been advanced. Smells have been classified by a German physiologist into groups which suggest that their perception is primarily a chemical process.*

It is a common experience to be reminded of past events by suddenly and unexpectedly encountering a familiar smell. We suppose that to most men the indescribable scent of an autumnal afternoon, that peculiar aromatic mixture of dying leaves, damp earth and a taint of wood smoke, together with a certain nip in the hazy atmosphere, brings to their mind the green stretch of turf to the white goalposts – the playing fields of their schooldays. To many the smell of "solidified alcohol," as it is called, brings a reminder of a dug-out in the Salient, or elsewhere. Of what these smells may conjure up to the feminine imagination we, who are of sterner mould, can claim to have no idea. Some picture they must make, for all smells are individual and associative to a greater or less extent according to our personal response to our surroundings. Those who know tell us that it is impossible to give any notion of colour to a man blind from birth, but to a man whose blindness came upon him after he had seen and known it, needs but the word blue or yellow to enable him to visualize the colour of the sky or of the flowers in his hand; all smells are equally associative with their substances as are colours and their names. Hence a person asked to tell the smell of a substance will say it is like violets or onions, rubber or tar, as it may be. And it is upon this association between smells and the substances giving rise to them that we are able to form a consistent theory of the olfactory sense, as physiologists term it.

Scents and Odours.

Most people divide smells into two classes, nice and nasty, scents and odours or, as our grandfathers more emphatically called them, stenches. To those who analyse their sensations more finely smells become "like heliotrope," "like verbena," or "onions" or "tar" and so on.

Physiologists have endeavoured to be yet more exact in their definitions, and the well-known German physiologist Henning has recently divided them into six fundamental classes.

(1) Spicy odours such as that of fennel, sassafras oil, anise and cloves.

(2) Flowery odours, such as heliotrope, coumarin and geranium oil.

(3) Fruity odours, like oil of orange, citronella and amyl acetate (the well-known pineapple flavouring used in sweets).

(4) Resinous or balsamic odours, such as those of turpentine, Canada balsam and eucalyptus oil.

(5) Burnt odours, like tar or pyridine (the penetrating odour of burnt hair).

(6) Foul odours, like carbon bisulphide (often smelt in dirty green-grocer's shops) and hydrogen sulphide (rotten eggs).

Although there are smells that fall half-way between these classes, yet generally these are the fundamental groups into which all smells can be put. As we shall see later, these groups correspond very closely to the chemical composition of the substances, and hence Henning's classification is one that will ultimately prove of value to all who take up the study of smell, for any classification of smells must be based upon chemical composition if it is to be of scientific worth.

A Chemical Process.

The olfactory sense is as much a chemical one as a nervous one. That this must be so we may bring as evidence the common knowledge that it is possible to exhaust, or tire out, the olfactory sense with one particular odour. For example, it is well known that people who work in nauseating odours readily become so accustomed that they cease to notice them, but they can, curiously enough, readily detect another odour. For instance, workers in a tallow factory soon become used to the smell of the fats and bones they handle, but can easily detect a bad or burnt tallow by its smell. Similarly the user of a perfume soon ceases to notice it, and indeed gains the impression that the scent has lost its power, accordingly they put on more and more until finally they move in a perfect "sea" of it. If, however, another and different scent is brought near them, they can quickly detect and name it. This points to the theory that the olfactory sense must be more or less chemical. Further evidence in favour of a chemical theory is that many people are what may be termed partially scent-blind as many are partially colour-blind. This condition is

* "The Sense of Smell." By Dr. Eric Ponder, *Discovery*, March, 1926.

known as partial anosmia, and its existence must be due in some way to the person's failure to respond to the chemical stimulus of particular smells, although they can perceive others perfectly.

The actual organ with which we smell is a section of yellow skin or epithelium situated in the upper part of each nostril. This epithelium is sensitized by a collection of nerve threads known as the olfactory nerve, and this conveys the sensation to the olfactory bulb of the brain. Laid out flat this epithelium would form a thick square of skin approximately 25 mm. square. The most important parts of it from our point of view, the sense of smell, are the olfactory cells; these are long rod-shaped cells that run from the surface of the epithelium to the base, and terminate there in a thread-like nerve fibre connected to the brain. The upper or outer end of these cells is a dome-shaped bulb that projects beyond the surface of the epithelium. Attached to this bulb are several very long and fine hairs which project into the layer of mucous matter that forms a protective coating to the sensitive epithelium in a healthy man. These hairs, of which there are from five to seven attached to every human olfactory bulb, and as many as twelve in those of some snakes, pick up the molecules of scent that enter the nostril and send through the cell a nervous message to the brain. They therefore act as transformers, turning the chemical vibration they receive into a nervous one.

All odorous substances vaporize in the atmosphere in the same way that water does. The molecules they throw off in evaporating or vaporizing are dissipated in the atmosphere and give rise to their scent. That is to say, the scent that enters our nostrils and comes into contact with the olfactory hairs are neither more nor less than the actual molecules of the substance we smell.

We now come to the manner in which these molecules act upon the hairs of the olfactory cells and, although it is extremely difficult to ascertain this, yet provided our theories are sensible and not far-fetched we can form a fairly truthful picture.

Layers of Molecules.

Chemists and physicists have, from a vast amount of experimenting and calculation, come to the conclusion that the molecules of gases and liquids can and do settle in layers one molecule thick upon the surface of metals such as platinum in those chemical phenomena included under the name of catalysis. What catalysis is does not concern us here, but what does concern us is that gaseous molecules can settle on a surface in a layer of a certain thickness, namely of one molecule. Also it has long been known that when oily liquids such as oleic acid are poured upon water in a layer of one molecule thick their molecules lie with one end in the water and the other in the air. Sir William Bragg and his fellow workers have recently shown that the molecules of these oils are really rod-shaped, and so can put their heads in water and stick their tails in the air. Hence, since the molecules of gases and liquids used in catalysis have different ends, then, say the physicists and chemists, they can lie on the metal with their heads among the molecules of the metal, and their tails in a given direction. Thus they have made a very workable theory of catalysis.

How the Theory Works.

To return to smell. The surface of the hair of the olfactory cell is covered with a fatty compound known as a lipoid. All smell molecules are more or less soluble in fats and hence it is reasonable to suppose that the odour molecules immerse themselves partially in the lipoid in the same way as oleic acid molecules do in water. This causes the hair to send the appropriate message to the brain. This theory is made all the stronger by the fact that the most powerful smells are those that are the most soluble in lipoidal liquids. Hence when the monomolecular layer, *i.e.*, the layer one molecule deep, completely covers each hair, we have the familiar sensation of the exhaustion of the olfactory sense for that smell. When now we allow molecules of another odour to enter the nose they will displace some of those in the monomolecular layer already there, and give the sensation of the smell we associate with them. Hence it seems but reasonable to suppose that the nervous messages sent to the brain will vary according to the chemical composition of the odorous molecule entering the lipoid covering of the olfactory hair. Henning's classification of the fundamental odours is found to bear this out when the chemical composition or shape of the molecules of the odours is studied.

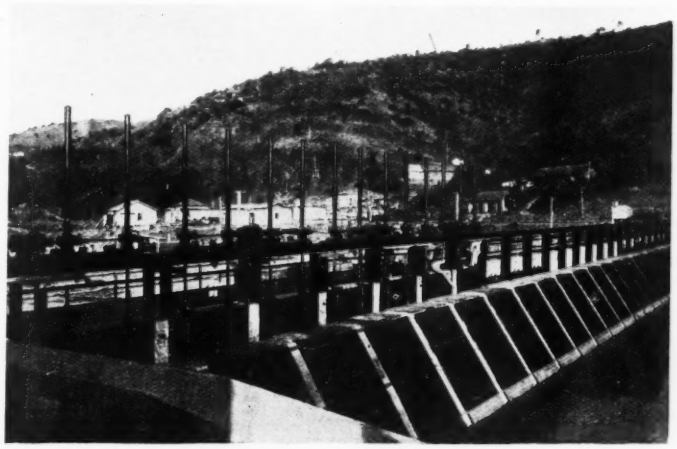
It is quite conceivable that in people suffering from partial anosmia the lipoid covering differs from that in normal persons, and is unable to dissolve certain molecules, hence such persons cannot smell those particular odours.

The familiar sensation of "having no smell" that occurs when we are afflicted with a heavy cold is quite easily explained. In a cold a vast deal more mucus is produced than in normal healthy life, this naturally forms a deep layer over the olfactory epithelium and covers the olfactory hairs; so preventing the molecules of any odour from reaching them.

Water-Power Developments.

Effect on Coal Production.

IT is not yet generally realized that one of the reasons for the troubled conditions in the colliery industry is that coal is no longer supreme as a source of energy in the production of power, light, and heat. This is not so much due to petroleum oil, contrary to popular opinion, as to the enormous developments of water power, which has now reached a total output in the world of over 35,000,000 h.p. What these figures mean is well illustrated by the fact that Great Britain, one of the three or four great industrial countries of the world, requires a total of about 10,000,000 h.p., while the world's annual output of coal during the past three years has remained stationary at about 1,300,000,000 tons. Almost every country to-day is developing water power, and a typical example of a country little thought of in this connexion is Brazil where, according to the U.S. Geological Survey Reports, at the end of 1923 450,000 h.p. was in operation, out of a total of 675,000 h.p. in the whole of South America, while great extensions continue to be made. One of the most important developments, for example, is the Parahyba scheme for the supply of electricity to Rio de Janeiro, which is situated on the Ilha dos Pombos, near the town of Antonio Carlos, on the Parahyba River, the installation being on the latest lines and including very large water turbines, while the overhead transmission lines, fixed on steel towers, are 155 kilometres in length.



LARGE WATER-POWER SCHEME ON THE PARAHYBA RIVER, BRAZIL, in connexion with the supply of electricity to Rio de Janeiro.

The accompanying photograph shows a part of the very extensive operating head-stocks, sluice fittings, and gantrey crane which have been supplied for this scheme by a leading British firm, comprising eight 3.0 by 4.3 metre steel regulator gates, operated by means of electric-driven worm and screw gear head-stocks, and twenty flood gates of the same dimensions actuated by means of electric-driven gantrey cranes. This is a very fine equipment, and the contract includes the completed head regulator to the off-take canal, and also two of the largest free-roller steel sluice barrage gates ever constructed in the world. These measure 42 ft. 3 in. by 38 ft. 3 in., and the complete weight of each finished gate is 57 tons, the method of operation being on the modern principle with complete trains of thirty-three cast-iron rollers at each side to ensure absolutely even distribution of the heavy load on the roller paths. The individual rollers are 9 in. long and 8 in. in diameter, and are supported in a steel cage with flat sides to which the axles of the rollers are riveted, while the method of operation is by combined hand and electric power at the rate of approximately two feet per minute. Further, it may be mentioned that the whole cage of rollers is shrouded within the gate groove to eliminate vibration and ensure protection from the errosive effect of the water passing through.

Another significant example of rapid advances in the use of water power is contained in *Annali dei Lavori Publici*, the official journal of the Italian Ministry of Public Works, who have been engaged in collecting statistics on the question since 1920, the above data relating to the years 1920-1924. The information is not complete because it appears that a number of firms refused to supply figures, but with regard to the generation of electricity by water power in 1920 there were 276 hydro-electric stations in Italy, generating 933,500 kW., while in 1924 the figure was 378 stations with an output of 1,534,863 kW., that is, an increase of 102 stations and no less than 601,363 kW. in four years.

Life-History Problems of Crustacean Larvae.

By Robert Gurney, M.A., F.Z.S.

The life-histories of crustacea present many interesting problems. The varied forms of larvae of crustacea—which include the crabs and lobsters, besides countless smaller water creatures—are probably modifications of a common type, but by adaptation to environment they have often acquired features that obscure this underlying unity of type.

WHILE many crustacea leave the egg in a form very much resembling that of the adult, the majority hatch out as free-swimming larvae so different from the parent that the true relationship may be difficult or even impossible to determine by simple examination. Among the more primitive crustacea, of which the fairy shrimp (*Chirocephalus*) may be taken as a type, the larva, when first hatched, is known as a nauplius and consists of a simple unsegmented body with three pairs of appendages only. The limbs are the two pairs of antennae and the mandibles, and the second antennae and mandibles are generally two-branched structures which are used as oars. The nauplius is a larval form of the greatest interest, since not only do most of the lower crustacea or Entomostraca start life in this form, but it also reappears in the life-history of some of the higher crustacea or Decapods (Fig. 1). In a great many cases the period of free larval life has been much shortened or even suppressed, but a nauplius stage may generally be recognized in the embryo, showing that this simple form of free larva was at one time general and is the characteristic larva of the crustacea as a whole. Some have even supposed that it represents the ancestral form from which the crustacea have descended, but it is more probable that it is a modification of the larva of a worm-like ancestor.

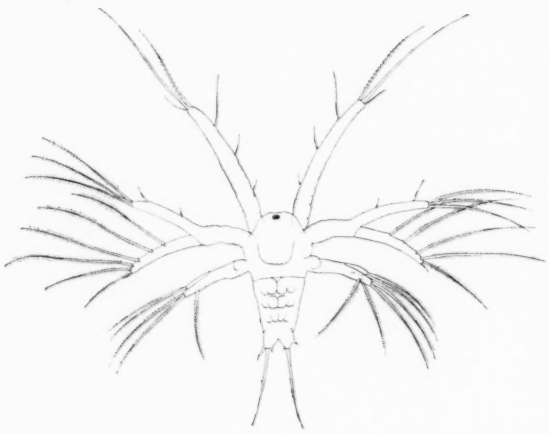


FIG. 1.
NAUPLIUS LARVA OF A PENAEID PRAWN (PENAEOPSIS) FROM THE RED SEA.
This form of larva, consisting of a simple unsegmented body with three pairs of appendages, occurs at some stage in the life-history of many of the crustacea.

Simple though its structure is, and similar in essentials in whichever group it is found, yet the nauplius has evolved a characteristic form in most groups by which its systematic position can generally be recognized. Perhaps the simplest and least modified type of nauplius is that found among the higher crustacea in the phosphorescent pelagic group of the Euphausidae, while the most striking modifications are seen in the nauplii of the barnacles.

In the most primitive crustacea, the Branchiopoda (*e.g.*, *Chirocephalus*), the adult form is assumed by gradual growth of the nauplius and addition of somites and appendages, without metamorphosis or abrupt transformation, but in other groups a pronounced metamorphosis often occurs at a certain stage in the life-history—this being the case, among the Entomostraca, in the copepods and barnacles.

In the higher groups of crustacea there is a strong tendency to abbreviate development, with the result that in many cases the free-swimming larva is entirely suppressed and the animal hatches almost or quite in the adult form. This is the case, for example, in Nebalia and in the opossum shrimps (Mysidae) and we are unfortunately deprived thereby of clues to their relationship which might otherwise have been provided by the larval stages.

Among the Decapoda, which include all the shrimps, prawns, and crabs, there is generally a long period of free-swimming larval life but, except among the Euphausidae and the primitive prawns of the family Penaeidae, the nauplius stage is passed through in

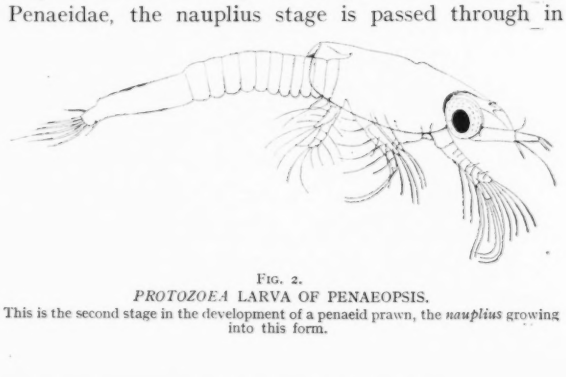


FIG. 2.
PROTOZOEA LARVA OF PENAEOPSIS.
This is the second stage in the development of a penaeid prawn, the *nauplius* growing into this form.

th egg. In the Penaeids the nauplius grows into a larva known as the protozoea (Fig. 2), which is of special interest, as it no doubt represents a very primitive form of larva or even may resemble an ancestral adult. Its chief point of interest is the possession of a dorsal shield or carapace which covers, but is not united to, the somites of the thorax, all of which are distinct. In this respect it resembles the primitive Branchiopods and Mysids, but differs from the adult Decapods in which all the thoracic somites are fused together, and with the carapace.

The Sergestidae, which are peculiar free-swimming prawns usually found only at considerable depths in the great oceans, are related to the Penaeidae, but their larvae hatch at the protozoea stage.

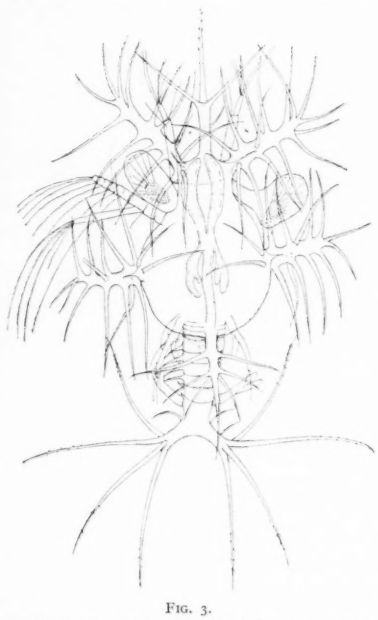


FIG. 3.
PROTOZOEA LARVA OF SERGESTES, A DEEP-SEA PRAWN.
The creature is armed with a thicket of long spines, affording a good example of adaptation to environment.

This protozoea is an extraordinary creature (Fig. 3), armed with a thicket of long spines, to which the name Elaphocaris has been given, and it is a good example of the way in which larvae, exposed as they must be to the operations of natural selection, may acquire characters, suited to their special mode of life, which may ultimately come to obscure the underlying unity of type. It is impossible to say what purpose these spines serve. They may be for protection, or for increasing buoyancy, but nothing whatever is known to support either suggestion.

The protozoea, at its third moult, transforms suddenly into a larva of shrimp-like form which, having all the thoracic legs present and two-branched, is known as the mysis stage. Whereas the protozoea probably as a rule hovers in a vertical position, using its antennae as swimming organs, the mysis larva swims horizontally by means of the outer branches of the legs and uses its antennae only as balancing organs.

In all the higher Decapods the nauplius stage is passed through in the egg, and the larva which hatches out is commonly known as a zoea (Fig. 4). In this

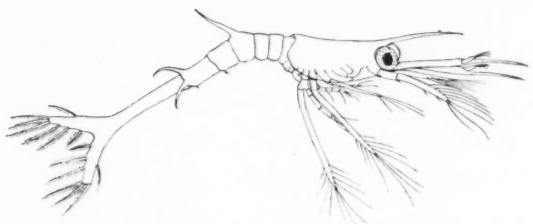
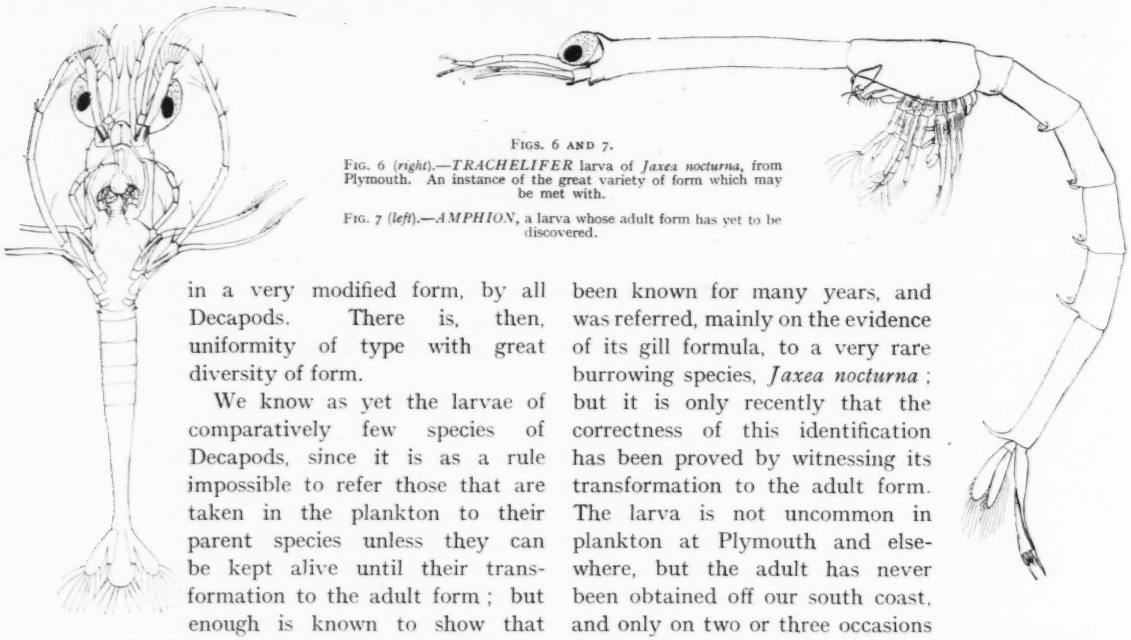


FIG. 4.
ZOEA LARVA OF THE SHRIMP *CRANGON SPINOSUS*
This type of larva appears to correspond to the protozoea of the Penaeid prawns.

larva there are either two or three pairs of branched swimming legs only, which later become the maxillipedes, the true legs of the adult being absent, and the thoracic region corresponding to them so compressed as to be apparently absent also. The zoea appears at first sight to be a larva special to the higher Decapods and not represented in the development of the more primitive Penaeids; but, if a detailed comparison is made between the zoea of a shrimp, for instance, and the protozoea of a Penaeid, it is found that there are certain resemblances between the two, and that these resemblances persist through the first three stages in the development of the zoea. The evidence, in fact, points to these three stages corresponding to the three stages of the protozoea. If this is so then there is exactly the same sequence in development in all Decapods, but the sequence has been obscured by the early appearance in the zoea of characters

FIG. 5.
PHYLLOSOMA LARVA OF A SPINY LOBSTER.
A specially interesting case of extreme transformation from type

which properly should belong to the later mysis stage, which is passed through, though sometimes in a very modified form, by all Decapods. There is, then, uniformity of type with great diversity of form.



FIGS. 6 AND 7.

FIG. 6 (*right*).—*TRACHELIFER* larva of *Jaxea nocturna*, from Plymouth. An instance of the great variety of form which may be met with.

FIG. 7 (*left*).—*AMPHION*, a larva whose adult form has yet to be discovered.

We know as yet the larvae of comparatively few species of Decapods, since it is as a rule impossible to refer those that are taken in the plankton to their parent species unless they can be kept alive until their transformation to the adult form; but enough is known to show that there are generally characters which distinguish the larvae of different families and sometimes those of genera or even species. Occasionally, as is the case among certain species of Crangon, and some Sergestidae, the larvae differ more than the adults from one another.

A specially interesting case of the extreme transformation of the larva is that of the spiny lobster (*Palinurus*) and allied genera (Fig. 5). Here the head and thorax form two flattened discs, with the abdomen reduced to insignificant proportion, and the legs two-branched and of enormous length. These larvae sometimes have a long free life, pass through a large number of moults, and grow to a great size before they transform suddenly to the post-larval stage resembling the adult. These larvae, whose parentage was for a long time unknown, received the generic name Phyllosoma, from the flat leaf-like body. The phyllosoma of a South African lobster (*Jasus lalandii*) possesses, when first hatched, enormous branched swimming antennae, and for some hours the legs remain coiled up and functionless while the animal rows itself with the antennae alone. For this reason the larva was called by Gilchrist, its discoverer, a naupliosoma. The phyllosoma and elaphocaris larvae are extreme examples of larval specialization and modification of a common type, but many other examples could be given to show the great variety of form or specialization of parts which may be met with.

One such instance is the peculiar long-necked larva known as the Trachelifer (Fig. 6). This larva has been known for many years, and was referred, mainly on the evidence of its gill formula, to a very rare burrowing species, *Jaxea nocturna*; but it is only recently that the correctness of this identification has been proved by witnessing its transformation to the adult form. The larva is not uncommon in plankton at Plymouth and elsewhere, but the adult has never been obtained off our south coast, and only on two or three occasions anywhere round Britain. A similar Trachelifer has been taken off the coast of New Zealand, but no adult *Jaxea* is known at present from the Pacific.

There are still problems to be solved with regard to these larvae apart from the light extended knowledge may shed on the classification of the Decapods. We do not know, for instance, even approximately, what is the adult form of the strange larva known as Amphion (Fig. 7). Again, there is no certainty as to the ultimate fate of certain larvae of unusual size which are occasionally met with. Some of these, such as some species of the larval genus *Retrocaris*, reach a size of 19 mm., and others up to 50 mm. Retrocaris is obviously a larva of a true prawn (*Palaemonidae*), but the palaemonid larvae of which the parentage is known do not grow beyond 10 mm. On the other hand, we only know the larvae of European prawns which do not, when adult, exceed about 10 cm., whereas some of the tropical river prawns (*Palaemon*) reach sizes of 30 cm. or more. Some of these river prawns probably breed in salt water, and it is possible that the large Retrocaris larvae are the normal young of these large river prawns.

The study of larval Decapods is a fascinating one in itself, for they are creatures of singular beauty, and they abound in the plankton of inshore waters in summer; and it is work which may lead to results of great systematic interest.

The Application of Psychology to Industry.

By R. O. Raphael.

Investigator to the National Institute of Industrial Psychology.

The theoretical aspects of psychology are the subject of so much current discussion that the steady advance in the application of the science to industry tends to be overlooked. The following describes the practical progress now being achieved.

IT used to be said that psychology as a science is in its infancy, as a sort of apology for the ambiguity of its terms, its lack of rigorous definition, and its poverty in mathematical statement. But a captious critic within recent times might almost reasonably have objected that the science was not in its infancy, but in its dotage: that psychology, the science of the soul or mind, had evoked the dialectical ingenuity of the world's greatest philosophical thinkers down to Spinoza and Kant, without ever emerging from the stage of metaphysical speculation towards precision of scientific statement.

Concrete Analysis.

Fortunately, such a sweeping criticism as this would hardly be true to-day. Within the stronghold of the traditional psychology there arose a body of workers who, tired of the barren discussions concerning mind in general, began to turn their attention more especially to the peculiarities of particular minds. The mental differences between individuals began to furnish them with the material for concrete analysis which had been lacking throughout the centuries. Thus, there has grown up a vast and miscellaneous accumulation of data which urgently demands to be sifted and systematized. The popular interest in individual differences was exemplified heretofore in the credence accorded to fortune-tellers, soothsayers, and other picturesque charlatans. Barren as they were, the childish activities of the phrenologist, the palmist, and the graphologist bear a similar kind of relation to modern empirical psychology as those of the mediaeval astrologer and alchemist bear to the work of the astronomer and chemist of to-day. They constituted the recognition of a need for causal argument in that border-line province which lies between the two realms of physiological structure and of human behaviour; but the very complexity and multiplicity of the data which lay ever ready to hand had driven man back from the task of systematic explanation to the resources of his own poetic fancy.

It might well be asked, How is it possible to ascertain with anything like scientific accuracy the extent of the mental powers which differentiate individuals?—How can anything so intangible as a degree of intelligence be susceptible of measurement? No doubt, it would be said, the psychological accompaniments of emotional states might successfully be recorded with the aid of apparatus, no less than what might be termed the constituent functions of intelligence, such as sensory acuity, memory span, association time, and the like. The ability to follow complex directions and to solve problems might likewise be recorded. But the critic might still insist that pure mental activity as such is intensive, not additive; that ratiocination does not differ from sensation as a mile differs from a yard; that states of mind differ qualitatively as, for instance, blue differs from green—not quantitatively or in any way that can be measured.

Now all this may be perfectly true. But the answer of the practical psychologist is emphatic and conclusive. He is concerned with function, with performance, not with mental processes as such; he is practical in the sense that he judges results alone. His investigations have convinced him that ability to perform one type of simple operation, or a ready reaction to a selected stimulus, is a reliable mark or sign of the possession by the subject of some mental quality, call it what you will, which will enable him successfully to respond to some other call upon his ingenuity or powers of judgment or control.

A Practical Purpose.

Emerging thus at last from the "sacred torpidity" of the university the psychologist, armed as yet with a slender equipment, but with an exceedingly definite and practical purpose, staked out a claim to utility in that bewildering and unsheltered wilderness—the field of modern industrial enterpriss. Here, indeed, it might have been thought that the academic mind would find scant pasture. But, not only has the industrial psychologist completely ratified his claim to be an indispensable servant to a progressive industrial society: he bids fair already to revolutionize many of the accepted

methods in counting house and factory; to show the hardest-headed and most practical minded employer of labour how to increase his output and reduce his expenses.

The Selection of Workers.

One of the most pressing problems in modern commercial life is the efficient selection of workers. It cannot be claimed as a fresh discovery that the good apprentice differs from the bad apprentice in the possession of a special aptitude for his work. Employers of labour are not slow to recognize a good employee from the quantity and quality of his output. But the need for fresh workers is constantly arising, and in the selection of these from the raw human material presented to his choice, the problem confronts the employer how to recognize the man or woman with the best mental equipment for the type of operation which he or she will be called upon to perform. It may be that the candidate has had some experience already, but without some intimate knowledge of his previous working conditions and of the individual himself, it is difficult to know precisely what interpretation to place on the "character" or written reference which he brings with him. Moreover, the fundamental question as to the suitability of the candidate for a particular job always arises in the instance of his first application, and it is an obvious economic maxim that every precaution should be taken to secure the right man for the right job.

The need for some method of vocational selection, therefore, has always been felt; the economic waste of a large labour turnover has been clearly recognized by big industrial concerns, and some measure of success has undoubtedly attended their efforts to reduce it. The careful scrutiny of letters of application; the personal estimate based on the interview; the rudimentary sample test of the work to be done—as, for example, the trial letter dictated to a typist—all these methods, which are in common use, indicate the widely felt need for a systematic sifting of the labour market on some scientific basis. From results alone it is fairly clear that this need has not been adequately met. The personal experiences of operatives and of employers alike make it clear that the square peg in the round hole—that symbol of financial loss and of emotional distress is all too frequently met with in industry.

It is the aim of the industrial psychologist to provide an instrument whereby the departmental manager, in considering applicants at his disposal, shall know exactly what qualities to look for and how to recognize those qualities when they are presented to him. The first requirement presupposes a somewhat specialized and technical analysis of the job itself with a view to determining the particular qualities, such as speed of movement, digital dexterity, accuracy of aim, aural acuity, etc., that may be required for its successful prosecution. The second requirement presupposes some reliable method of assigning to the individual subject a degree of relative proficiency in any or all of those simple sensory or motor constituents into which the piece of work has been analysed. In other words, it is necessary, for each kind of occupation, to frame a series of experimental tests which can be applied to every applicant under relatively constant conditions and are capable of giving results that can be expressed in quantitative terms.

Any operation which is a reliable measure of a certain ability will serve as a test; but the framing of really significant tests is a highly technical matter. Many of the most efficient of the tests have the appearance of nothing more than a puzzle or an amusing parlour game. For instance, in estimating the suitability of applicants for packing chocolates into boxes, it was found possible to make very accurate predictions from a trial of their ability to aim wooden draughts at a bull's eye. Other simple tests of this type are illustrated in the accompanying photographs.

Objections to Earlier Methods.

Before proceeding to describe the methods by which such tests are constructed, it may be as well to indicate under three headings the main objections to the earlier, unscientific attempts at vocational selection—such as the personal interview, the letter of application, the photograph, etc.

(*a*) They do not necessarily throw any critical light on just those qualities in the candidate which are most important for the purpose in view. A vocational test is based on an inside knowledge of the job which the worker will have to perform. Statistics will have proved already that the degree of proficiency displayed by a candidate in the performance of the test is a reliable mark of his ability in the performance of the actual job. And sometimes this bears very little direct relation to the qualities which are apt to impress the unaided judgment of an employer. The rapidity with which I am able to twist a metal screw home into a thread is found to be a better measure of my skill as a weaver than politeness, a smart appearance, or even general intelligence.

TESTING DRESSMAKERS' APPRENTICES FOR LIGHTNESS OF TOUCH.
They fold tissue paper and note is taken of the e tent to which it is crushed.

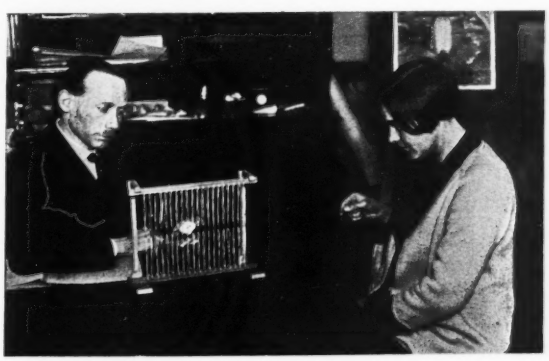
the *personal equation*, and it is certainly no less a factor of importance in vocational selection than in the natural sciences. In the correction of written examination papers it has almost invariably been found that where one and the same paper has been copied in a different handwriting and presented to the same examiner, there is a discrepancy in the number of marks allotted; where several days have been allowed to lapse between the correction of the two papers, this discrepancy is often startling. No less remarkable are the discrepancies between the findings of two or more examiners from one and the same paper. This is partly because there is not, and cannot be, any accepted canon for the allocation of marks under this system—*i.e.*, the examiner does not always know for what precisely he is looking. But no less important is the vitiation of the test by the unascertainable personal equation. That is to say, even if some absolute and objective standard were available, there is room in the method of scoring for those changes of feeling and temperament which turn the hero of one age or social group into the villain of another.

(*b*) The older tests of ability were not only sometimes misdirected; even if they had been satisfactory from that standpoint, they had necessarily to be employed under conditions that were not constant. They were not sufficiently experimental and objective. An essential feature of all experiment is to maintain constant all relevant conditions under which it is conducted. Vary those conditions and your results are simply ambiguous. In testing for visual acuity, the oculist displays to his client a printed card; the ability to read letters of a certain size at a certain distance is taken as the standard or norm of visual acuity. If the illumination of the test chart were allowed to vary as between one patient and another, or if the thickness of the strokes of the letters varied in different charts, the optician could never be sure how good the eyesight of several patients was in terms of standard visual acuity.

MEASURING SPEED OF PERCEPTION OF SHAPE.
The pieces of wood must be fitted into corresponding moulds.

In a similar way, it is impossible for me to ascertain with any degree of accuracy the relative degrees of proficiency of several typists if, for example, I vary the length or the difficulty of the passage to be copied. Moreover, my own frame of mind varies considerably in the estimation of the ability of candidates at different times. In experimental science, this is known as

(*c*) Finally, in the absence of any accepted standard of proficiency it was difficult, with any degree of accuracy, to



A WEAVER'S TEST: SPEED OF FINE MOVEMENT.
A series of loosely suspended eyelets are threaded by the applicant.

estimate the performance of an operative when once he had been accepted and passed through to the factory. The standard selected by the industrial psychologist is an empirical standard of proficiency in a certain operation based on an examination of the performance of a large number of persons. He then adopts quite pragmatically, and with an eye to the number of candidates available for the post, some point in the scale of proficiency approximating to that standard as a minimum above which he can say with some reasonable degree of confidence that the candidate will succeed at the task under consideration.

Constructing a Test.

In a certain tapestry-weaving factory in the North, a superficial survey of the sheds revealed striking differences in proficiency between girl operatives of the same age and experience working side by side on similar looms. Some time was first spent in getting into touch with conditions of work. The operatives, having once grasped the purpose of the inquiry, lent the investigator their ready assistance and much valuable information was thus forthcoming based on their own experience of success and failure. Trials made at the looms also elicited data of a suggestive kind as to what kind of capacities made for success in the work.

These capacities can be grouped under three main headings :—(*a*) accuracy of observation ; (*b*) speed ; (*c*) personality. On the strength of this analysis it was possible to frame tests devised to measure these requisite capacities in persons destined to become weavers. The following is a brief summary of such tests, classified under the headings given above.

(*a*) *Accuracy of Observation.*

1. Disparate attention. A number of cards are shown to the girl in succession and at a specified speed. She must be able to detect the presence or absence of a certain number of expected features on each card during each short exposure.

2. Discrimination of pattern. Twenty-four slightly varying patterns are briefly exhibited in pairs ; the girl records the difference between each pair.

3. Memory of pattern. As in Test (2) except that the patterns are simpler and are shown consecutively only and not simultaneously.

4. Discrimination of thickness. Twenty spools of yarn are to be arranged in identical pairs according to the quality of the yarn.

(*b*) *Speed.*

1. Fine threading movement. Measurement of the time taken to thread a stiff piece of wire through eyelets suspended from a frame.

2. Speed of turning movement. Measurement of the time taken to turn a screw with the right and left hands respectively, the hands being held in a position similar to that used in twisting.

3. Amplitude of turning movement. Measurement of the minimum number of turns taken in twisting a screw home with the right and left hands respectively.

4. Ability to plan work ahead. Observation of the skill displayed in traversing a maze sketched in outline ; foresight is required to avoid mistakes.

In addition, two other tests were applied, but they were discarded, as they showed low discriminative value when applied to weavers of known ability.

As half the twisters are trained to use the right hand only and half the left hand only, the tests for rotary movement (*b*) 1 and (*b*) 2 were of further use in providing a standard of comparison of the relative ability of each hand, thus indicating which hand should be trained. The tests were given individually, and took about half an hour to apply to each candidate. Special care was taken to overcome nervousness on the part of the candidates. By starting with easy tests and giving judicious encouragement, the skilled tester can generally succeed in putting the whole procedure on an easy footing. In fact, many candidates for employment spontaneously told the investigator that they prefer tests to an interview as they are "fairer and less terrifying." A special test-card was prepared for recording the results.

(*c*) *Personality.*

The personal qualities indicated under this heading would be ascertained by the interview, which the tests are designed to supersede.

Some Practical Results.

The above tests were applied to a group of weavers whose occupational abilities were unknown to the investigator ; the order of ranking according to proficiency was then correlated with the order of ability as given by the manager. Here are the two orders :—

Weaver.	Test ranking.	Manager's ranking.
A	1	2
B	2	5
C	3	1
D	4	4
E	5	11
F	6	7
G	7	8
H	8	
Pass level		
I	9	10
J	10	9
K	11	6
L	12	12
M	13	13

Of these, Weaver E was new to the work, so that, as the manager admitted, her weaving ability was not known to him, while Weaver K's work was poor,

but she was placed fairly high by the manager owing to the disciplinary and other qualities which she showed in her position of "second hand." Such qualities, of course, the tests described had not been devised to estimate. It is noteworthy that only one girl reached the pass level (marked by the line) who should not have done so according to the manager's ranking, and that only one girl failed to reach it whose general ability was satisfactory. Both of these special cases have been explained above. It will be observed that, with the latter exception, the last five places practically coincided in both rankings. Before the tests were applied, and unknown to the investigator, weavers L and M were to have been discharged in any case, and the tests merely confirmed their inaptitude for the work. But that decision had to be reached by a long and costly process of fruitless training. Much disappointment and expenditure of time and energy could have been saved by the application of vocational tests in the first instance.

Psychological Estimate Correct.

It will be seen that a very practical and searching verification of the validity of the tests was resorted to. The correct inductive procedure of comparing theory based on experiment with testimony afforded by observation of the real is illustrated here. In spite of the smallness of the group tested, a true relationship is shown, and the coefficient of correlation between the order given by the tests and by the manager's ranking respectively was very high (actually $.77 \pm .07$). Subsequent events have proved that where any big discrepancy was shown, the estimate of ability based on the psychological test proved itself to be the correct one.

In respect to the practical application of the results of this investigation, it should be added, in the first place, that the standards were first found empirically by the application of the tests to a typical group of persons similar to applicants for employment at this factory; secondly, that the operation of the tests was taught to the factory employment manager before the investigations were completed; in the third place, that the tests have now been part of the employment routine of the factory for over a year with eminently satisfactory results.

Enough has now perhaps been said to illustrate the practical working of these tests and to indicate the possibilities of their wider application to the field of modern industry. The advantages accruing to the employer from scientific methods of vocational selection might roughly be summarized as follows. Firstly, on the purely economic side, by providing a more suitable type of worker, they effect a direct saving (*a*) by decreasing the labour turnover in the factory; (*b*) by decreasing the amount of time spent by highly paid officials in the work of engaging and dismissing employees; (*c*) by reducing the damage done by relays of fresh workers to costly machinery and equipment.

Improved Personal Relations.

Secondly, while making for material improvement in the output of the factory, these methods relieve the executive of the moral responsibility of unfair selection or promotion of employes by providing the *justest* because the most *objective* methods of choice.

Thirdly, and largely by reason of this, they tend very greatly to improve the personal relations between employer and employed.

No less convincing is the argument from the standpoint of the worker. He cannot fail to reap advantage from a scientifically-directed and sympathetic inquiry into his specific tendencies and abilities. Instead of being regarded as a mere unit in the industrial machine, as a mere wealth-producing factor in an undifferentiated mass of human material, he sees himself treated less as a mere means than as an end in himself. Thus the stress that is laid by the industrial psychologist upon the individual peculiarities of each worker must, in the long run, be reflected in the very attitude of society as a whole towards the rank and file of industry.

The Humanitarian Aspect.

The practical effect of the efforts of the psychologist must be to increase the self-realization and self-respect of the worker and to raise his standard of life. Wherever the result of an industrial test is the purely negative one of diverting a worker from a job to which otherwise he might more or less automatically have been drafted, it is no exaggeration to say that a minor tragedy has been averted. The square peg has no cause for self-congratulation because he drops *easily* into the round hole. Once there, circumstances may conspire to keep him there with his potentialities permanently unrealized and his whole outlook needlessly embittered in consequence.

Thus the humanitarian aspect of vocational selection is no less striking than its purely economic aspect. If it is important that society as a whole shall increase its productive capacity, it is no less important that this tendency shall be concomitant with an increase in the contentment and happiness of the individual worker.

When Suffolk was Sub-Tropical.

By J. Reid Moir.

Some deposits in Suffolk, known as the Coralline Crag, afford interesting evidence of the prehistoric period in which the Eastern Counties enjoyed tropical climate. Whether human beings were living at that time may yet be revealed by excavation.

For a great period of time Suffolk basked in a Mediterranean climate, when what is now the North Sea teemed with wonderful shell-fish, and other forms of aquatic life that to-day are found only in far southern waters. To transport ourselves to this salubrious epoch it is necessary to go back about 1,000,000 years into the past, but, to the geologist, to whom a thousand years are but as a day, this is a very small matter. The Eastern Counties presented then a rolling landscape, with much scrub and jungle, numerous streams, and open stretches of water, and were inhabited by large herds of strange animals long since eliminated in the onward march of evolution. In the deposits known as the Coralline Crag, laid down by the sea of this period, there have been found, among other treasures, the great volute, the cameo shell, the *pirula*, or fig shell, and the large lamp shell *Terebratula grandis*. Corals also abound, and it is difficult to believe that the cold grey North Sea ever nourished such exotic and tropical forms of life. But if a visit is paid to Sutton, Orford, or Aldeburgh, in Suffolk, large pits can be seen, which are sunk in the Coralline Crag and there, before one's eyes, is proof of this former warmth and gentleness.

The Coralline Sea.

At this time the Coralline Sea was landlocked towards the north, thus cutting it off from the cold Arctic waters, and Suffolk must have been a very pleasant place in which to live. But, at present, it is not known for certain whether any human beings were in existence in those days. The presence of flint implements beneath the Red Crag is established, but the Coralline Crag is considerably older, and no definite relics of man have so far been found beneath it. During the laying down of the Coralline, the Suffolk land surface was gradually sinking, as such surfaces at times have a habit of doing. This submergence was no doubt very slow, perhaps about two inches in a century, but it went on until large tracts of East Anglia were inundated and the cold waters of the Arctic Ocean irrupted into the Crag basin with dire results to the beautiful marine fauna flourishing in the warm Coralline Sea. It will be realized that as the land went down objects lying on the surface would be quietly washed into any depressions existing there, and be covered up by the marine deposits then being laid down. So it is at the base of the Coralline Crag that search must be made for the remains of man, if such exist at this level. But this is by no means an easy matter, because this bed was almost entirely removed when the incoming cold Red Crag Sea got into its stride, and only comparatively small areas of the Coralline have been left for examination; and in most places its base is so deep down, and water-logged, as to make archaeological excavations in it an impossibility.

Remarkable Finds.

But many years ago Professor Prestwich saw and described the base of this deposit at Sutton, near Woodbridge, where there had been found a remarkable series of organic specimens, including a molar tooth of the great elephant-like mastodon. So, just before the war, another pit was opened at the same place, and near to that examined by Prestwich, but unfortunately no such assemblage of fossils as he records were revealed. It was, however, a very arresting sight that met the eyes of the excavators when, after great difficulties in coping with water, they at last reached the junction of the Coralline Crag and the underlying London Clay. The marine sands were of a pale greenish tint, and in them the shells lay in horizontal lines—the two valves of the large clams, cockles, etc., being conjoined as in life, and all are in a very perfect unrolled state. There are few people living who have seen the base of the Coralline Crag, and it is generally in such unget-at-able places that Nature hides some of her most beautiful treasures. The archaeologist, however, is not interested, primarily, in shells, lovely though they be, but keeps his eyes wide open for flint implements, "worked" bones, and—if the gods are kind—a portion of the skeleton of man himself. In the excavations carried out at Sutton, only one small flint came to light that has the appearance of having been humanly shaped. It is a flake, of a creamy white colour, and its edges have been trimmed, by secondary flaking, so that it might have served as a knife, or a scraper, for some East Anglian of pre-Coralline Crag times. It is tempting to regard it as

such but, on the other hand, its flaking may have been due to non-human, natural forces, and in any case it would never do to attempt to push man's antiquity still further back into the past on the evidence of merely one small piece of flaked flint. So, for the present, we must possess our souls in patience, and wait for future researches to tell us whether human beings were living in Suffolk when the North Sea smiled under a sub-tropical sun.

It is true there is preserved, in the small museum at Aldeburgh, the upper portion of a human skull that is said to have been found at some depth in the Coralline Crag at this place. Some years ago a workman unearthed it while digging in the Coralline Crag, but it was not seen *in situ* by any competent geologist or archaeologist. Further, the skull is of quite modern type, and shows little or no signs of fossilization such as all bones found hitherto in the Coralline Crag exhibit; and it seems safer to assume that this specimen found its way into the Crag by means of an intrusive burial, than that men of the modern type were inhabiting Suffolk about 1,000,000 years in the past. But, in spite of the present lack of evidence of the existence of pre-Coralline Crag man, it is not at all improbable that such would be found if excavations could be carried out at places like Sutton where the base of this Crag can be uncovered. Large and expensive expeditions are being sent out to China, from America, having as one of their principal objects the discovery of the remains of our earliest ancestors, though the evidence that such will be found in that part of the world is of the slenderest. If only similar expeditions could be organized here to examine the considerable tracts of country in the Eastern Counties where there is very good reason to believe the most ancient traces of man could be discovered, there can be small doubt that the results achieved would be of great scientific importance, and could be obtained with comparatively little expenditure of money.

Inventions and How to Patent Them.

Points the Inventor should observe.

The following advice on patent law has added interest in view of the International Exhibition of Patented Inventions to be held in London this month.

ALTHOUGH the advantages conferred by patent protection are now fairly well appreciated, there are a number of points in connexion with the patenting of an invention which the inventor should be acquainted with if he is to obtain the maximum benefit from his patent, even though he may employ a patent agent to advise and assist him.

A question which often arises is that of the ownership of an invention. If the inventor is his own master and has made the invention himself there is no difficulty, but more frequently the inventor is an employee of a firm or company, and other considerations arise. If the invention has been made by an employee as a result of the research which he has been employed and instructed to undertake, then it is clear from decisions in the courts that the patent belongs to the employer. If, on the other hand, the employee has suggested some improvement outside his regular work and which he was not expected or employed to make, then the patent that may be obtained belongs to the employee, even though the improvement may have been made as a result of his experience and knowledge gained with the employers. Even if a patent belongs to the employers, the actual inventor must always be a co-patentee with the employers. It is always better to have an agreement beforehand as to ownership or part-ownership of any inventions which may be made.

The Specification.

The first step in patenting an invention is usually to file a provisional specification which, as its name denotes, is a document that describes only the nature of the invention without going into the details. The object of this provisional specification is to give the inventor the benefit of protection as soon as he has put his inventive idea roughly into practical shape. He is given nine months in which to work out the details of his invention, and he must then file his complete specification, which must contain a full and complete account of the invention. The provisional specification should be filed at the earliest possible moment in order to get the earliest date for the patent and so forestall possible competitors. The specification should contain all the information which the inventor has relating to the invention, and it should indicate the probable lines of development of the invention which the inventor proposes to take. If the invention relates to a process, the specification

should cover the application of the process to all circumstances to which it is applicable, even though the inventor may only have investigated one of these in detail. The period of provisional protection can be used to investigate further the scope of the invention.

A provisional specification will usually be accepted by the Patent Office without much difficulty, since no search in regard to the novelty of the invention is made until the complete specification is lodged.

When the provisional specification is filed, a period of nine months is allowed in which to file the complete specification. An extension of one month only can be obtained on payment of a fine of two pounds. The complete specification must contain a full and accurate description of the invention, and must end with the " claims " which define the scope of the patentee's protection. These claims should be drafted as widely as possible to cover all possible applications and alternatives of the inventive idea, and should as far as possible anticipate any attempts at infringement which might be made by working the invention outside the strict limits of the claims. A search for novelty is made on these claims covering all British specifications filed within the last fifty years, and objections may be raised that the invention has been partly anticipated. It will then be the inventor's duty to limit his claims in the light of these prior inventions, still claiming the invention as widely as possible, and to make clear exactly what advance he has made.

Obtaining Adequate Protection.

The development of the invention and the drafting of the complete specification are matters of great importance if the inventor is to obtain the greatest possible protection for his invention, and it must here be emphasized that the lines which he should follow in his further research with a view to filing the complete specification are not usually quite the same as those which he would follow if he merely wished to improve and develop his apparatus or process from a commercial point of view. For instance, it would be very unwise for an inventor to perfect the working details of some piece of mechanism without considering the possibility of using a mechanical equivalent ; or for a wireless enthusiast to patent a wonderful new circuit he has invented, without considering various electrical alternatives, *e.g.*, electrostatic, instead of electromagnetic reaction. In short, the problem before the inventor is not so much to produce a process which is worked out to the last detail, but to generalize and extend his net as widely as possible so as to include all possible modifications and alternatives, and thus obtain the maximum protection to which his original idea is entitled.

In this connexion the theory that underlies an invention is important, not so much for insertion in the specification, but as a guide to the direction in which research ought to be made, and to the way in which the invention should be generalized when set out in the specification.

Faults in Specifications.

A patent specification is supposed to be addressed to those " skilled in the art " to which the specification relates, and the specification should contain sufficient information to enable the invention to be carried into practice without any further research. " That the description is insufficient " is a frequent ground of opposition to a patent in the courts, and the inventor would do well to study this question closely. The most common fault in this connexion arises when the inventor does not give proper warning of special conditions to be observed, or precautions to be taken to work the invention successfully. Another very frequent fault arises when an inventor has invented an improvement in some detail of an existing machine or apparatus, or in a chemical process. Very often the incorporation of the improvement necessitates the slight modification of some other part of the machine or process, and if the inventor does not make this quite clear in his specification he runs the risk that his patent may be invalid on the ground that further research would be necessary in order to carry it out.

Statements of advantages are not necessary in a specification, and are a source of danger. Patents have been held invalid because the patentee stated that certain results were obtained which could not in fact be obtained by his invention, though other valuable results were obtained. Theory may be introduced merely as an explanation of the way in which the inventor thinks the process works, but he should be on his guard against any statements liable to mislead. If statements of advantages are included they should be confined strictly to proved facts.

Vagueness of the scope of the claim is another cause of invalidity. Since the patentee is claiming the right to prevent the public from doing certain things, it is only fair that he should define clearly the limits of his monopoly. Thus, in the recent case of the gas-filled tungsten lamp, which depends upon the use of a comparatively thick filament compared with the vacuum lamp, a claim involving the words " filament of large diameter or cross section " was held to be invalid because it did not define the limits

of the protection claimed. The inventor has to steer a middle course between a claim which is sufficiently broad to include something old or which will not work, and a narrow claim which may give him insufficient protection. It is a point which needs very careful consideration.

In drafting the specification and claims the inventor must keep in mind not only the protection of the invention which he desires to work, but he must endeavour to anticipate the action of possible infringers. He must consider: (1) Does the inventive idea of the specification suggest a possible alternative which might be patented and worked by a rival? The claims could probably be made sufficiently wide to cover possible alternatives if the inventor takes the trouble to investigate these in the nine months following the provisional specification; (2) Could the invention be improved? If so, he should include any such improvements in the complete specification or in one or more patents of addition. A rival is quite at liberty to patent an improvement and to prevent the original inventor from using it but, conversely, he cannot use it himself unless he is granted a licence under the original patent, or until that patent expires; (3) Could a rival use substantially the same idea and yet keep outside the claims of the patent by using a device which was not quite as efficient? He might consider that a sacrifice of ten per cent in profits was good business if he thereby avoided payment of a twenty per cent royalty. The inventor should take care to include within his claims not only those conditions which give the best results, but all those which will give any useful result.

Patent Procedure.

An application for a patent is made on a form bearing a £1 stamp, and may be made by any person, alone or in conjunction with other persons, or with a company or firm. This form must specify who is or are the actual inventor or inventors, and such inventor must be a party to the application. The form must be signed by all the applicants.

The application form is accompanied by a provisional specification which should set out the broad lines of the invention without going into great detail, and should be so worded so as to cover as fully as possible all variations, modifications, and alternatives of the invention which the inventor desires to protect. No stamp is required on the provisional specification.

A maximum period of nine months is then allowed for the development of the invention in detail, during which the inventor is protected by his application and provisional specification. The complete specification must then be lodged, bearing a £3 stamp, and must fully describe the invention and the best method or methods known to the inventor of carrying it out. After this period no addition or development is allowable. If several provisional specifications relating to similar subjects have been lodged, they may afterwards be combined as "cognate," and may be completed by a single complete specification, and a single patent obtained. A search for novelty is made on the invention claimed in the complete specification, and the inventor may be required to restrict his invention as the result of prior description of his invention in part, notified to him by the Patent Office. In extreme cases, if there is no novelty whatever in the invention, the application for a patent is refused. Any formalities or amendments necessary in connexion with the complete specification must be completed within fifteen months of the original application, and the specification is then officially accepted.

An Alternative Method.

As an alternative to the above procedure, the provisional specification may be dispensed with, if the invention is fully developed at the time of the application, and the complete specification may be filed at once with the application. By this means the patent may usually be obtained at an earlier date, but no development or addition may be made once the complete specification is filed. The fees are the same, *viz.*, £1 for the application and £3 for the complete specification.

After acceptance, the specification is printed, and any person interested may, within two months, oppose the grant of a patent. If no opposition is made, or if it is made and fails, the patent is sealed upon the applicant paying a sealing fee of £1, and the patent is issued. The minimum cost of obtaining a patent is thus £5.

Various additional fees and fines may become payable if the applicant desires extensions of time for complying with various requirements, *e.g.*, the time for lodging the complete specification may be extended from nine months to ten months from the date of application by payment of £2, and the time for acceptance may be extended for one, two, or three months by payment of £2, £4, and £6 respectively.

The patent remains in force for four years, after which a renewal fee of £5 is payable for the fifth year, £6 for the sixth year, and so on up to £16 for the sixteenth year. The patentee may apply to have his patent indorsed "Licences of Right," which means that he must be prepared to grant licences upon

favourable terms to any person, or in default of agreement, upon terms to be decided by the Comptroller of Patents. In consideration of this, he pays only half the renewal fees.

Patents of addition for small improvements or modifications of the original invention may be obtained, to expire when the main patent expires, and for these no renewal fees are payable.

An applicant has the privilege of obtaining protection in most countries of the world under the International Convention and of having his patent dated the same date as that of his application here, if he applies abroad within twelve months after that date. The fees and other conditions are those which are in force in the various countries concerned, and the arrangements are reciprocal.

Any further information regarding patent procedure may be obtained from H.M. Patent Office, 25 Southampton Buildings, Chancery Lane, London, W.C.2.

The Story of Imitation Pearls.

By G. Malcolm Dyson, Ph.D., A.I.C.

Most people think of pearls as being either "genuine" or "artificial," but this classification leaves out of account an important third type which has no connexion with the oyster. The "imitation" pearl is only related to the real article by appearance, and is the product of an old-established industry at Yarmouth.

THE pearl as a precious gem depends to a considerable extent upon shape and texture for its beauty, while the size and regularity of contour control its market value. However, the actual substance of the pearl is identical with that of the interior lining of the shell of the mollusc which produces it, and consists of alternate layers of micro-crystalline calcium carbonate, similar to that forming certain of the hard chalks, and of a hard horny substance known as conchiolin, the exact nature of which has not been completely elucidated. The faint irridescence which characterizes the finest pearls is caused by the light interference phenomena which take place at these thin layers. Pearls and their imitations may be divided into three classes—the true, artificial, and imitation pearls.

True pearls are the spontaneously produced products of various molluscs which inhabit the southern seas, although they have been found in British fresh-water shell-fish of the genus *Unio*. The principal sources, however, are the pearl oyster (*meleagrina margaratifera*) and the pearl mussel (*avicula margaritifera*). The irritation set up by a particle of foreign matter stimulates the occupant of the shell to protect itself by covering the intrusion with the secretion referred to above, and so a pearl comes into existence. Much argument has taken place about the nature of the particle causing the irritation. In some cases it has been traced to a grain of sand, but in the majority of cases it is a small parasite which attacks the shell-fish early in its life-cycle and is dealt with in the manner described.

The second class of pearls, the artificial or "cultured" pearls, are in reality identical with true pearls save that the particle of foreign matter is inserted by artificial means. If the particle of matter used is as small as that occurring naturally, the pearl obtained in the end would be exact in all details of similarity with the true or spontaneous pearl; but in order to shorten the time of "nacring" the size of body inserted is often quite large. In such cases an X-ray examination or a density determination may point to the use of abnormally large nuclei.

A French Discovery.

Imitation pearls have no connexion with the oyster, and are only related to the real article by appearance. The synthetic or imitation pearl industry dates from 1656 when Jaquin, the famous Frenchman, found that the water in which a certain fish (a species of fresh-water bleak—*albinus lucidus*) had been washed, was clouded with irridescent and glittering spangles which by long standing and continued washing he was able to obtain in the form of a paste. Noting the pearl-like lustre of this paste, especially when dry, he conceived the idea of coating small hard beads with a mixture of this paste and wax and so prepared the first imitation pearl.* The imitations were apparently successful, and "caught on" well with the public of that day, since it is recorded that they were the fashionable craze of the time, no lady's jewel box being complete without a string of the new beads. Contemporary literature contains an interesting story of a penniless marquis who tricked a young girl into belief of his pecuniary stability by means of a string of Jaquin's imitation pearls.

A large French industry gradually sprung up, to

* "Beytrage zur Geschichte der Erfindungen," Vol. II, Part III

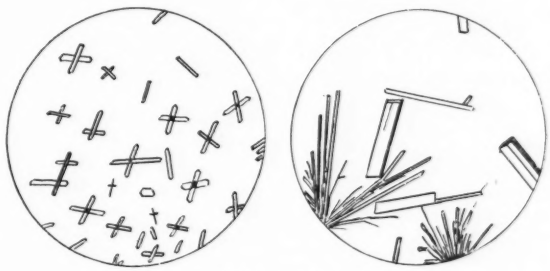
which the scientist Reaumur made reference in 1716, noting, at the same time, that the liquid used was a suspension and not a true solution. The pearl essence, as it was—and still is—termed, had to be prepared freshly every few days by fractional washing of the fish scales. It is recorded that in thundery weather the essence might putrefy in a few hours. The method of preservation with concentrated ammonia was apparently not known.

The present-day methods of preparation of pearl essence are not fundamentally different from those used two and a half centuries ago. In France and other continental countries the source is still the various species of the bleak, while in this country the essence is obtained from the herring (*clupea harengus*). The English centre of manufacture is, as might be expected, Yarmouth. The fish from the nets are gently washed with water to remove salts and various impurities. The belly scales are then given a scrape with the back of a knife and are then thrown into a tank of running water. The pearl essence is washed out of the loosened scales, and by sedimentation of the suspension obtained the pearl essence is obtained. The fact that the tiny irridescent platelets absorb colouring matters from solution makes the cleaning of an essence suspension a matter of considerable difficulty, and renders the highest cleanliness necessary in all stages of the operations. If the essence is to be preserved in aqueous suspension a large excess of ammonia is added in order to arrest putrefaction. The more modern practice is, however, to suspend the dried plates in a pure organic solvent such as acetone or amyl acetate. This facilitates its conversion into pearl varnishes or artificial mother-of-pearl. The organic media used must be absolutely free from the slightest traces of water which, if present, will cause all the particles to clot together in a mass that cannot be again dispersed.

A Chemical Puzzle.

The nature of the pearl essence was a puzzle for a considerable period. Emmerling in 1833 reported that the substance suspended in the water was of purely organic origin and contained no metallic bases, but Du Mesnil contradicted this several years later, stating that the crystals were in actual fact small platelets of metallic silver ! This surprising statement he based on the fact that the pearl essence gave a black precipitate on the addition of a solution of ammonium sulphide, and that solutions of silver salts give similar precipitates under these conditions. Goebel disproved this wild statement, and Schnitzlen showed that the substance responsible was an organic compound containing nitrogen. Finally Barreswill showed that the plates were minute crystals of guanine, and Vort confirmed this diagnosis by a detailed chemical analysis.

Guanine is a simple derivative of a basic substance known as purine, and from it are derived a large number of compounds of first importance in the vegetable and animal kingdoms. Thus guanine occurs in the excreta of various animals, especially of spiders, snakes and birds, and has been observed in the crystalline form in the iris of the eye of frogs. Caffeine and theobromine are other derivatives which are found to a considerable extent in our national beverages—tea, coffee and cocoa—and are the substances to which these fluids owe, in part, their stimulating and refreshing character. They have been known to occur in the crystalline condition in certain leaves.



FIGS. 1 AND 2.
CRYSTALS OF GUANINE AND ITS COMPOUND HYDROCHLORIDE.
The pearl essence obtained from the scales of certain fishes contains guanine.

In the animal kingdom the derivatives of purine play a very important part, and when built up into complex molecules known as nucleic acids, the purine bases play an important part in the metabolism of both plants and animals. Thus adenine is found in the pancreas of herbivora, and uric acid is a characteristic component of the excreta of all animals. The building up of certain units of muscle and cell matters is done by the aid of these substances, and it is no exaggeration to say that animal life partly depends on the formation and decomposition of purine derivatives. Further, as is well known, an excess of uric acid is the cause of gout, deposits of this purine body being formed in the joints of the body.

Guanine, the purine of pearl essence, is almost universally found in the scales of the smaller fish. Its function is, of course, for camouflage, a silvery light being reflected from the guanine crystals, which occur chiefly on the under side of the fish, and makes the latter almost invisible when viewed from below. Guanine can be prepared by chemical means, but the crystals of guanine (Fig. 1), or of its compound hydrochloride (Fig. 2) are nothing like so brilliant as

those obtained naturally, and from the point of view of pearl essence are valueless. The latter substance owes its brilliance, not only to the fact that the light passing through it is doubly refracted and polarized, but also to the extreme thinness of the crystals. Thus crystals from the scales of the shad are on the average 0.1 ×0.02 ×0.001 mm. in dimensions, having a volume of 0.000000002 c.c. and a mass of 0.000000032 gm. A gram of such crystals represents about a square metre of surface.

Testing for Impurities.

The qualities of first importance in pearl essence are the fineness of grain, brightness of lustre, and absence of tint or impurities. The first three attributes can only be judged by means of experience and comparison, but the presence of impurities can be easily demonstrated in the following manner. A film preparation is made on a slide and stained with aqueous "methylene blue." Microscopic examination will show up any organic impurities (fragments of scale, tissue, etc.), stained a deep blue, the guanine crystals remaining colourless. The fineness of grain can, of course, be observed microscopically, and a rough evaluation can be obtained by a "count" of the crystals on a ruled slide similar to that used in blood counts. Such a method is, however, tedious and is usually replaced by a chemical method. A weighed amount of the essence either in aqueous or organic suspension can be evaporated to dryness and the amount of nitrogen in the residue estimated by a test known as "micro-Kjeldhal," the guanine being estimated from the fact that it contains 46.36 per cent of nitrogen. The process is inaccurate in that it calculates all nitrogenous impurities as guanine. The best chemical method of evaluation is by estimation as guanine picrate. The guanine is brought into solution by the addition of a sufficient amount of fifth-normal hydrochloric acid and precipitated as guanine picrate by the addition of an excess of a saturated aqueous solution of picric acid. Guanine picrate is comparatively insoluble—1 part in 30,000 of water at ordinary temperature. The precipitate, which is microcrystalline, can be easily filtered off and its one molecule of water of crystallization removed by heating for 1½ hours at 110° C.

The glass beads for treatment with pearl essence can be made in a variety of ways. For the cheapest brands a row of bulbs is blown from colourless soft lead glass into a mould and the individual beads severed at the constrictions. Such bulbs are usually characterized by a ridge on either side and are only used for very inferior work.

For external coating "solid" beads are made from short lengths of thick-walled capillary tubing. These are heated in a rotating cylindrical vessel filled with talc powder. The latter prevents the softened beads from adhering to one another, while the softening converts them from the cylindrical to the spherical shape. For the best work thin lamp-blown glass shells are made by a special process, the holes for threading being blown by the aid of a perforated screen. Hollow beads are coated on the inside with a thin layer of pearl essence in amyl acetate varnish, and considerable skill is required to obtain an even grain. The coated beads are then filled with wax of the right colour, usually Japanese wax with a loading of barium sulphate. Such beads are easy to break, while the "solid" beads coated externally are not only more realistic but less easily fractured. They have a serious disadvantage in that the coating is liable to wear off.

Genuine *versus* Imitation.

Whatever controversies may rage between experts concerning the differentiation of real and "cultured" pearls, the imitation pearl can be readily distinguished from the genuine article. In the first place the density of a real pearl is fairly constant at 2.6, while hollow imitations are usually much lighter and, while the holes of the real pearl are obviously drilled, those of the artificial article are rounded. The irridescence is a particularly good test of genuineness. True pearls are faintly—one might almost say "elusively"—irridescent, and have a matte surface which will not give sharp images of distant objects by reflection. Internally coated pearls, if not "doctored," give sharp images by reflection, and even if "doctored" by the action of hydrofluoric acid or potassium hydrate solution, the result of the treatment is so obviously artificial that an expert eye is not deceived. The colour produced on the surface of glass of these reagents is far too bright and crude when compared with the genuine article. The real pearl is unaltered by immersion in amyl acetate, but rapidly disintegrated by dilute hydrochloric acid, while the reverse is true of the externally-coated imitation.

In connexion with pearl essence it is worthy of note that an excellent "synthetic" mother-of-pearl can be prepared by adding a strong acetone suspension of the essence to a liquid synthetic resin, and then hardening it by heat to the next more complex chemical stage. Provided suitable starting materials are chosen the resultant resin can be split into thin layers and the material so formed finds an extended use in the manufacture of ornamented articles.

The Month's Wireless Developments.

BROADCASTING IN GERMANY.

By Edward Liveing, M.A.
(Manchester Station Director, B.B.C.).

THE entry of Germany into the League of Nations has created so much general interest in that country's affairs that it may be interesting to readers of *Discovery* to know something about the German broadcasting organization and its plans.

Owing to restrictions put upon German broadcasting in the early days by the Allied Powers, Germany did not take to the air as quickly as the other great nations of Europe, but she has made up for this delay by very rapid strides during the last two years. In many ways the German broadcasting organization is similar to that of the British organization. It comes under a central authority and the present radio commissioner for Germany is Dr. Bredow, formerly State Secretary of the German Ministry of Posts. Like the British organization, it has paid much attention to the establishment of a simultaneous broadcast system by which important ceremonies and concerts can be relayed from one station to another and so broadcast throughout the country. The standard of programmes is high, as might be expected of a country famous for its contributions to music and the methodical way in which it tackles big problems. Germany may fairly lay claim to having established a broadcasting system that ranks next to the British.

Present developments and future plans show that Germany means to make great progress in the development of this new medium of expression. The Berlin, Hamburg, Munich, and Leipzig stations have now been increased to a transmitting power of 10 kw. each, and the four other main stations—Breslau, Frankfurt-on-Maine, Stuttgart, Nuremberg, and Koenigsberg—will be put up to the same power shortly. Germany has its relay stations like Great Britain, and they cater for crystal-set users in some very thickly-populated areas.

The broadcasting restrictions have for some time past been removed from the Rhineland, and a high-power station with an energy of 60 kw. is to be established at Langenberg. It will probably be opened at the end of this year, and its opening will result in the closing down of the Dortmund and Elberfeld stations, though these will be transferred to a district south of Cologne and to Rheinpfalz respectively.

Most interesting of all is the news that Germany will shortly possess a high-power station of 100 kw. The Koenigswusterhausen station, so well known to owners of valve sets, which has hitherto been working on a power of 20 kw., is to be given this new power.

The German authorities attach great importance to the educational side of broadcasting, and they also hope to co-operate effectively in European broadcasting by means of "wired wireless." In this connexion it should be pointed out that a great deal is being done at present by most European countries in the improvement of the telephone service and the institution of underground cables.

"The Illustrated Wireless Story."

A recent experiment was made at the Manchester station of the British Broadcasting Company of presenting a version of a cinema play. The immediate significance of this experiment lies in the fact that wireless has knocked at the door of another art form. No attempt was made to reproduce a broadcast version which would actually synchronize with the unreeling of the film. What was done was a performance of a version of the film-story which, by means of appealing to the ear, carried the listener through the plot as the cinema carries its audience forward by appealing to the eye. The general descriptions of the story-teller took the place of the cinema "sub-titles," the dialogue of the actors and actresses and suitable noise effects supplied the scenes, and orchestral music tinged the unfolding of the story with the requisite emotional atmosphere. Much remains to be done in the improvement of the technique of what might be called the "illustrated wireless story." This and other experiments have, however, shown that a new form of radio drama may be developed which need not rely on set stage-scenery and which will take the listener swiftly from one scene to another, leaping over the old barriers of "exits" and "entrances."

THE WIRELESS EXHIBITION.

By F. H. Masters.
Editor of "The Electrician."

IN suggesting that I should devote this month's article to the Wireless Exhibition, which was held at Olympia, London, last month, the editor has set me a hard task. It is difficult to begin, and it may be still more difficult to leave off.

On the human, rather than the technical side, the most striking thing was the interest taken in the exhibition by all classes of the community. This, however, is not surprising, for as Sir William Bull has pointed out there are now 3,000,000 official broadcasters in this country, as well as a considerable number of others, who have not gone through the formality of taking out a licence. A large number of both these classes are not satisfied merely to switch on their sets and listen, but are constantly attempting to improve them and, what is not always the same thing, to increase their capabilities. The other human feature was the queue outside the British Broadcasting Company's model studio. Of the many thousands who listen in, very few have been inside the headquarters at Savoy Hill, or the transmitting stations in other towns. There was, therefore, widespread curiosity to see the "aunties" and the apparatus they use in the flesh. This "close-up" view of the transmitting organization may, in fact, be a not unimportant element in the development of broadcasting.

The Technical Side

On the technical side the exhibits showed that manufacturers are paying increasing attention to the requirements of that large body of listeners who are not scientifically trained and want their sets to give the best possible results with the least amount of bother. The result is the production of a much more highly sensitive and selective apparatus, in which easy control is a predominant feature. At one end of the scale there are a number of multi-valve sets, with which the programmes of British and Continental stations can be received by the movement of one or two dials, and at the other are sets with which the local station can be tuned in merely by pressing a button. This is a notable advance over last year.

In general, too, it may be said that the sets are more scientifically designed, a state of things which is indicated by the care manufacturers are taking to secure better reproduction. This

will be helped by the correlated improvements, which are being made in loud-speaker design. It may be added that a great variety of these instruments were on view, most of the models having large conical or radially pleated paper diaphragms. A step, which may not be a progressive one from the accoustical point of view, is to combine the loud-speaker with a rose-bowl or picture, with the idea of concealing its real object. Nevertheless, it can hardly be denied that the loud-speaker is still the weak link in the chain, and that the energetic steps which are being taken to better it must be continued.

Although some of the sets are still too complicated to be easily used by the amateur listener, that charge certainly cannot be laid against what was probably the real novelty of the exhibition. This was Sir Oliver Lodge's "N" circuit. This, as is well known, has been specially designed to prevent local interference, one of its fundamental principles being the employment of a single connexion between the aerial system and the detector valve. The "N" circuit proper is included between the aerial and detector grid, and consists of a variable condenser in shunt with an inductance. This forms a resonant circuit. On the other hand, the aerial is non-resonant and is heavily damped. The coil has a fairly high inductance, and the capacity of the condenser is small. The result is that, owing to the much greater wave-length of the system and to its damping, radiation from the aerial cannot occur to the disturbance of near-by listeners.

Greater simplicity than heretofore was also to be found in the actual connexions of many of the other sets. Intervalve coupling and selectivity were common, and the indications are that the life of the super-heterodyne is to be meteoric. The critical visitor to the exhibition was, of course, faced with the usual difficulty of claims being made for apparatus which can only be substantiated after prolonged test. It is therefore perhaps wise to leave the sets, of which, of course, there are an increasingly large number, and say something about the various components.

With regard to inductances, it was noticed that valiant attempts are being made to reduce the losses due to self-capacity and high-frequency resistance by air-spacing and the interaction between adjacent coils. For this purpose special forms of winding are used, and the coils are enclosed in metallic casings. In many of the condensers extremely fine adjustment was provided accompanied by plates of special shape, so that when used with a fixed inductance a straight-line characteristic is obtained.

Another interesting tendency was to be found in the successful attempts which have been made to reduce battery troubles and annoyances by laying the public electricity supply under tribute. Several sets which could be operated directly from the house lighting mains were exhibited, as well as a number of more or less simple devices for charging batteries at home. Another piece of equipment, of which several examples were on view, is the H.T. battery eliminator. This is designed to enable the required high-tension battery to be taken from the lighting mains. These devices, whether intended for connexion to a direct or alternating current supply, must be used in combination with some device for smoothing out the ripples. Such apparatus must always contain a rectifying valve. Some of the patterns shown contain two separate anodes and filaments so that a single valve can rectify both halves of the a.c. wave. A particularly interesting valve was the "Ethotron," which has the advantage that it allows the smoothing apparatus to be eliminated.

It would be possible to continue almost indefinitely, but enough has been said to show that the home constructor is well catered for, so much so that the range of accessories on view was not a little bewildering. As a whole the exhibition was one of which the National Association of Radio Manufacturers and Traders may well be proud, for it showed conclusively that this country leads in the production of apparatus for what may truly be called an essential service.

Book Reviews.

A History of English Literature. Vol. I: "The Middle Ages and the Renaissance (650-1660)." By EMILE LEGOUIS. Translated by HELEN DOUGLAS IRVINE. (J. M. Dent & Sons. 10*s.* 6*d.*).

One of the most illuminating and deservedly popular histories of our literature is that of Taine, but even those readers who are most capable of appreciating its lucidity and originality are aware of its grave defect. Taine was so much attached to certain theories about race and environment, that he gave false pictures of many men and women of genius who were too great to be classified as specimens. They transcended or violated the laws of ordinary development. It is not enough to say of Milton that he was a Puritan, or of Chaucer that he was an Englishman. M. Legouis and his fellow professor in the University of Paris, M. Louis Cazamian, have written a history which avoids Taine's error. M. Legouis, who in 1910 published a brilliant study of Chaucer, and in 1923 a fascinating book on Spenser, is the author of the first volume, which brings the story down to the Restoration, while his colleague, in Vol. II, conducts it to our own time. There are certain obvious disadvantages that have to be met by any foreigner who undertakes to deal at length with the many hundreds of authors who must be mentioned in a compendious history of English literature. Some of those whom we understand instinctively he may not appreciate; some whom we love in spite of their insufficiencies and because of some touch of kindred feeling, he may judge by purely intellectual standards. Moreover, translation, no matter how good, is an unfortunate necessity.

The present volume has been well translated, and a careful examination of its contents shows that the author has rarely if ever failed to understand the spirit or to enjoy the technique of our poets and prose writers. This is saying a great deal, but not more than is deserved by M. Legouis, who is probably the most eminent continental English scholar and an authority not only on the mediaeval and Elizabethan periods, but on Wordsworth and the other Revolutionary poets. The worth of this book is, however, to be found chiefly in the very fact that it is by a foreigner. The views in it are fresh. They are free from nationalistic bias and partisan tendency. The criticism is in general aesthetic rather than moral or political. The arrangement is in certain points unusual. Especially valuable is the constant stream of light thrown upon the subject by comparison with French poetry.

At the outset M. Legouis states boldly and plainly his conviction that Anglo-Saxon is not Early English, and that English literature did not exist before the Norman Conquest. In a few quietly ironic sentences he shows that he thinks the majority of scholars in the past fifty or sixty years have been misled by German sentimentality and pedantry and by English nationalism, by the desire to extend our claim as far back as

possible and to present the picture of an unbroken and ever-broadening stream flowing from the sixth or seventh century. In this contention he has commonsense and history on his side. It is true, as he says, that "complete ignorance of Anglo-Saxon poetry is no barrier to understanding Chaucer, but to be ignorant of French mediaeval poetry is to be entirely unacquainted with Chaucer's literary origins." He is perhaps too sweeping when he insists that "the qualities and deficiencies of a language predetermine the field of poetry and its successes and failures almost independently of the personal genius of the poets who use it," but the predisposing power of a language is a factor in literary history that is too often overlooked. And he is splendidly right in asserting that More's "Utopia" is the true prologue of the Renaissance in England. Altogether, M. Legouis has given us a book rich in suggestions and soundly original.

GEORGE McLEAN HARPER.

Iron in Antiquity. By J. NEWTON FRIEND, D.Sc., Ph.D. (Charles Griffin & Co. 1926. 10*s.* 6*d.*).

Dr. Friend has an interesting subject with which to deal, and he has already shown his competence in the matter by a number of preliminary studies of ancient specimens of iron and by memoirs on the archaeology of that metal. He begins with a survey of the origin of the use of metals by primitive man, and avoids the temptation, to which many metallurgists have succumbed, to suppose that, because iron is so easily reduced from its ores, it must have been smelted at least as early as copper. The archaeological evidence is against such a supposition, and Dr. Friend takes the sounder view that the use of iron was at first merely sporadic, and depended on the discovery of meteoric iron, which could be forged. He does not enter into the vexed question of the cradle of the iron-smelting industry, but reviews impartially the facts concerning its early occurrence among both prehistoric and historic races, noticing in passing the evidence from language. A table of the probable dates of the successive Hallstatt and La Tene periods in different parts of Europe is included without comment. From this the author passes to a series of special studies of the use of iron as ornament and as currency, and thence to a geographical survey of iron in various parts of the world, confining his attention to early times except in so far as modern survivals throw light on ancient methods. The chapter on iron as currency brings together a number of interesting facts which are not easily accessible in textbooks. He has devoted special attention to the subject of the mention of iron and steel in the Scandinavian sagas, and brings together from several sources a number of interesting facts in this connexion, from which we may gather that the production of a tough steel was a problem which was very imperfectly solved by the Norsemen. He seems to have missed the remarkable process for the rehardening of steel attributed in the Edda to the Scandinavian equivalent of Wieland the Smith. One objection, however, must be brought against a statement in this chapter. On the strength of a remark in a saga that one of the personages possessed a sword which would not rust, it is suggested that this might be because it was badly oxidized during its forging and was therefore covered with a thick layer of mill-scale. This is untenable, as the scale would break off during the forging, and a sword so coated would be useless. The author has been misled by noticing the presence of a thick hard layer surrounding Roman and other ancient iron objects, which he has taken for mill-scale, but which is really a mineralized product of iron rust. With this exception, the author is to be trusted as a guide to the metallurgical details of his treatise. He has made many personal observations, both on material in museums and on the site of archaeological discoveries. Rather more might have been made of the history of iron in China and Japan, where the wonderful metallurgical skill of the two peoples is as strikingly evident as in their treatment of bronze and other alloys. A very short section on the development of the blast furnace from the hearth or bloomery concludes the book, which does not pretend to be more than a brief sketch. The fuller details must be sought in the monumental work of Beck, or in the remarkably comprehensive recent work of Johannsen, but Dr. Friend has provided English readers with a very pleasing account, in simple language, of a highly important aspect of early civilization. The illustrations are not numerous, but are of a simple explanatory character. If a second edition should be called for, as it deserves, it might be well to explain the old bloomery in more detail, as remains of such furnaces are common in many parts of our islands, and it is of interest to trace out, by local names and traditions as well as by actual material survivals, the beginnings of an industry which has meant so much to our country.

CECIL H. DESCH.

Shakespeare Heroines Souvenir Book. (Published by the British Broadcasting Company Ltd. on behalf of the Shakespeare Memorial Fund. 2*s.* 4*d.* post free.)

"The Shakespeare Heroines Souvenir Book" has been designed to act as a memento of a series of Sunday afternoon broadcasts from the London studio of the B.B.C., given by distinguished actors and actresses under the title of "Shakespeare's Heroines." It is also intended to act as a contribution towards the Shakespeare Memorial Theatre Fund.

Forewords have been contributed by Miss Lilian Baylis, Sir Frank Benson, and Miss Edith Evans, and these are fortunately very brief for their authors have nothing to say and Sir Frank Benson has not acquired the art of saying it. The book itself will delight those who admire the gifts of Mr. Charles Ricketts, A.R.A., who has contributed thirteen drawings, two of which are in colour, twelve being concerned with stage settings. Each scene depicted by the brushes that translate Mr. Ricketts' sympathy and imagination is accompanied by notes which summarize the character of the particular heroine concerned, and Rosalind, Lady Macbeth, Juliet, Portia, Desdemona, Beatrice, Viola, Ophelia, Cleopatra, Katharina, Hermione and Katharine of Aragon are dealt with in turn. The book is not very well planned or produced, and suffers from the lack of a title page; but the illustrations redeem its faults and make it worth having.

J. G.

Macedonia, Thrace and Illyria: Their relation to Greece from the Earliest Times down to the Time of Phillip, son of Amyntas. By STANLEY CASSON, M.A. (Oxford University Press. 21*s.*)

Macedonia and Thrace presented an ethnological problem to the classical writers which modern research is only just beginning to solve. The Greeks were agreed that the Thracians were barbarians; political considerations coloured the views with which the claims of the Macedonian rulers to be Hellenes were regarded. Mr. Casson has assiduously collected the references in the writers of antiquity which bear on these questions, and has surveyed the archaeological evidence from prehistoric times onward in the quest of a solution. Archaeologists are now in the main agreed that in this area of the Balkans we have a key position to the early relations of the Aegean and East Central

Europe. Here we find prehistoric sites which point to it being the meeting-place in the Bronze Age of the cultures of Mycenae and of the north.

Mr. Casson has put forward some interesting and suggestive theories as to racial movements in the Neolithic, Bronze, and Iron Ages, but much must, as he points out, be regarded as tentative pending more extended research. Of what has been done, including his own excavations in Macedonia at Chauchitsa and Kilindir, he gives a lucid and well illustrated summary. His admirable chapter on "Geographical Considerations" is an interesting account of a peculiarly intricate and difficult area. The material has been difficult to handle, but the author has succeeded in making it tell an intelligible story.

The Upper Palaeolithic Age in Britain. By D. A. E. GARROD, B.Sc., Oxon. (Clarendon Press, Oxford. 10*s.* 6*d.*).

In a foreword to this volume the distinguished French archaeologist, the Abbé Breuil, points out the difficulties which he has encountered in attempting a comparative study of the Upper Palaeolithic Age in countries other than France. Miss Garrod's object has been to meet these difficulties, so far as Britain is concerned, by collecting the material from its scattered sources in old and often obscure publications and subjecting it to a critical examination, illustrating it fully with figures of typical implements, many of which have not previously been published. The greater part of her book is taken up with the finds in caves extending from the work of Buckland and M'Enery in Kent's Cavern in 1824, to that of Mr. Armstrong at Creswell Crags in 1924 and 1925, of which some account has been given in *Discovery*. In addition Miss Garrod deals with the surface finds, among which are included the implements from East Anglia which have been assigned to the Solutrean period, and the epipalaeolithic industries, the Azilo-Tardenoisian implements of England and Scotland. The great value of Miss Garrod's book lies in the light which it throws upon the interesting, but still obscure, problem of the relation of this later phase of the Old Stone Age in Britain to that of the Continent, *i.e.*, how far the sequence of the Aurignacian, Solutrean, and Magdalenian periods with the succeeding epipalaeolithic industries—Azilian and Tardenoisian—holds good here. Recent investigations, in particular the excavations by Mr. Armstrong, to which reference has already been made, and by the Spelaeological Society of the University of Bristol in the Mendip Caves, which are here discussed by Miss Garrod, have produced evidences of Magdalenian influence for which, when taken in conjunction with other peculiarities of our Stone Age culture, it is not easy to account. The author's theory of a "provincial" culture is the best reasoned explanation of the facts that so far has been put forward.

E. N. F.

Books Received.

Stone Decay and its Prevention. By J. E. MARSH. (Basil Blackwell. 3*s.* 6*d.*).

Shakespeare Heroines Souvenir Book. (British Broadcasting Co. Ltd. 2*s.* 4*d.*).

The Atmospheric Nitrogen Industry. By DR. BRUNO WAESER. Translated by ERNEST FYLEMAN, B.Sc., Ph.D., F.I.C. Vols. I and II. (J. & A. Churchill. £2 2*s.*).

Monthly Circular of Recent Selected Publications. Nos. 89 and 90. July and August, 1926. (H.M. Stationery Office).

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The Building Research Station. (H.M. Stationery Office).

Sibylla, or the Revival of Prophecy. By C. A. MACE, M.A. (Kegan Paul, Trench, Trubner & Co. Ltd. 2*s.* 6*d.*).

Natural History. (Second-hand books) Catalogue. August, 1926. (W. & G. Foyle Ltd.).

General Strikes and Road Transport. By GEORGE GLASGOW. Introduction by the RT. HON. D. LLOYD GEORGE, O.M. (Geoffrey Bles. 5*s.*).

The Babbitt Warren. By C. E. M. JOAD. (Kegan Paul, Trench, Trubner & Co. Ltd. 6*s.*).

Sex in Man and Animals. By JOHN R. BAKER. Preface by JULIAN S. HUXLEY. (George Routledge & Sons Ltd. 7*s.* 6*d.*).

The Comparison of Sunshine Recorders of the Campbell-Stokes Type. Professional Notes. No. 45. (H.M. Stationery Office. 6*d.*).

The Element of Aerofoil and Airscrew Theory. By H. GLAUERT. (Cambridge University Press. 14*s.*).

Considerations Relative to the Age of the Earth's Crust. By THE HON. SIR FREDERICK REVANS CHAPMAN. (Reprint from *Transactions of the New Zealand Institute.* Vol. 56. Pp. 112-120).

The Fireballs of November 15 and December 29, 1925. By WILLARD J. FISHER. (Harvard Reprint 31).

On the Distribution of Intensity in Stellar Absorption Lines. By CECILIA H. PAYNE and HARLOW SHAPLEY. (Harvard Reprint 28).

Mr. Belloc objects to "The Outline of History." By H. G. WELLS. (Watts & Co. 1*s.*).

The Goodness of Gods. By EDWARD WESTERMARCK. (Watts & Co. 1*s.*).

Theoretical Biology. By J. VON UEXKÜLL. Translated by D. L. MACKINNON, D.Sc. (Kegan Paul, Trench, Trubner & Co. Ltd. 18*s.*).

Leaves from a Northern University. By A. F. (Kegan Paul Trench, Trubner & Co. Ltd. 7*s.* 6*d.*).

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Magnetism and Atomic Structure. By EDMUND C. STONER, Ph.D. (Methuen & Co. Ltd. 18*s.*).

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British Journal of Actino-Therapy. Vol. 1. Sept., 1926. No. 6. (The Sunlight Bureau. 2*s.*).

On the Trail of Ancient Man. By ROY CHAPMAN ANDREWS, Sc.D. (G. P. Putnam's Sons. 25*s.*).

A First Course in Wireless. By ROBERT W. HUTCHINSON, M.Sc., A.M.I.E.E. (University Tutorial Press Ltd. 3*s.* 6*d.*).

The Generation of Very Intense Magnetic Fields. By T. F. WALL, D.Sc. (Reprinted from *Journal of the Institution of Electrical Engineers.* Vol. 64. No. 355. July, 1926).

Journal of the Franklin Institute. Sept., 1926. Vol. 202. No. 3. (The Franklin Institute of the State of Pennsylvania. 60 cents).

The Stone Age in Rhodesia. By NEVILLE JONES. (Oxford University Press. 12*s.* 6*d.*).

Bird Study in India. By M. R. N. HOLMER, M.A., F.Z.S. (Oxford University Press. 4*s.* 6*d.*).

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